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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBSYSTEM SPECIFICATION

MULTIMODE DIGITAL RADIO (MDR)

The NEXCOM Integrated Product Team, AND-360

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RECORD OF CHANGES

Revision	Date	Action
0.0	4/27/2000	Version 21a MDR SSS Draft Baselined as Revision 0.0
1.0	6/30/2000	Incorporation of the following approved IRB CRs: IRB CR 0002 IRB CR 0003 IRB CR 0004 IRB CR 0005 IRB CR 0006 IRB CR 0007 IRB CR 0011 IRB CR 0012 IRB CR 0013 IRB CR 0015 IRB CR 0016 IRB CR 0017 IRB CR 0018 IRB CR 0020 IRB CR 0021 IRB CR 0022 IRB CR 0023 IRB CR 0025 IRB CR 0026 IRB CR 0027 IRB CR 0028 IRB CR 0029 IRB CR 0031 IRB CR 0034 IRB CR 0035 IRB CR 0036

		IRB CR 0041 IRB CR 0042 IRB CR 0043 IRB CR 0044 IRB CR 0045 IRB CR 0046 IRB CR 0048 IRB CR 0051 IRB CR 0053 IRB CR 0055 IRB CR 0056 IRB CR 0057 IRB CR 0058 IRB CR 0059 IRB CR 0060 IRB CR 0061 IRB CR 0062 IRB CR 0063 IRB CR 0064 IRB CR 0065 IRB CR 0067 IRB CR 0068 IRB CR 0069 IRB CR 0070 IRB CR 0071 IRB CR 0072 IRB CR 0074
2.0	8/8/2000	Incorporation of the following approved IRB CRs: IRB CR 0075 IRB CR 0076 IRB CR 0077 IRB CR 0078 IRB CR 0082

		IRB CR 0083 IRB CR 0084 IRB CR 0085 IRB CR 0087 IRB CR 0088 IRB CR 0090 IRB CR 0092 IRB CR 0093 IRB CR 0094 IRB CR 0095 IRB CR 0096 IRB CR 0100 IRB CR 0102 IRB CR 0108 IRB CR 0109 IRB CR 0110 IRB CR 0111 IRB CR 0113 IRB CR 0115 IRB CR 0116 IRB CR 0117 IRB CR 0119 IRB CR 0120 IRB CR 0121 IRB CR 0122 IRB CR 0123 IRB CR 0128 IRB CR 0144 IRB CR 0149
3.0	9/20/2000	IRB CR 0150 IRB CR 0155 IRB CR 0163 IRB CR 0171

		IRB CR 0176 IRB CR 0177 IRB CR 0179 IRB CR 0180 IRB CR 0181 IRB CR 0183 IRB CR 0184 IRB CR 0185 IRB CR 0186 IRB CR 0187 IRB CR 0190 IRB CR 0191 IRB CR 0192 IRB CR 0193 IRB CR 0194 IRB CR 0195 IRB CR 0196 IRB CR 0200 IRB CR 0203 IRB CR 0204 IRB CR 0205 IRB CR 0206 IRB CR 0207 IRB CR 0208 IRB CR 0209 IRB CR 0210 IRB CR 0211 IRB CR 0212 IRB CR 0214 IRB CR 0215 IRB CR 0216 IRB CR 0217 IRB CR 0218

		IRB CR 0219 IRB CR 0220 IRB CR 0221 IRB CR 0223 IRB CR 0225 IRB CR 0227 IRB CR 0228 IRB CR 0229 IRB CR 0241 IRB CR 0243 IRB CR 0244 IRB CR 0246 IRB CR 0247 IRB CR 0248 IRB CR 0250 IRB CR 0251 IRB CR 0252 IRB CR 0254 IRB CR 0255 IRB CR 0256 IRB CR 0257 IRB CR 0258 IRB CR 0259 IRB CR 0260 IRB CR 0261 IRB CR 0263 IRB CR 0264 IRB CR 0265 IRB CR 0266 IRB CR 0267 IRB CR 0268 IRB CR 0271 IRB CR 0273

4.0	7/23/2001	Incorporation of the following approved IRB CRs: IRB CR 0274 IRB CR 0277

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1.0 SCOPE

1.1 Identification

This document contains the subsystem specification for the NEXt generation air/ground (A/G) COMmunications (NEXCOM) System Very High Frequency (VHF) radio, to be used for A/G voice and data communications. It describes the features and performance required by the NEXCOM System radio equipment to satisfy Segment One of the NEXCOM Program. This document was prepared in accordance with the format requirements of FAA-STD-005e.

The physical/functional architecture of the NEXCOM equipment is judged by the Federal Aviation Administration (FAA) to be the most cost effective of various approaches for NEXCOM Segment One, and should provide the smoothest transition into the National Airspace System (NAS). This specification covers only the ground-based radio equipment, the Multimode Digital Radio (MDR), to be purchased by the FAA. Since RTCA DO-224a, Minimum Aviation System Performance Standards (MASPS) applies to avionics, differences between the MASPS and specific needs of the ground station equipment are reflected in this specification. Initially the MDR radio is intended to operate as a 25 kHz Double Side Band-Amplitude Modulated (DSB-AM) radio. The radio will also operate at 8.33 kHz DSB-AM and VHF Digital Link (VDL) Mode 3. Most of the VDL Mode 3 timing, framing, vocoding, and link management described in the RTCA DO-224a (MASPS) will be demonstrated by the Radio Interface Unit (RIU) during initial digital deployment. The MDR/RIU will be tested and fielded as a VDL Mode 3 and DSB-AM compliant system.

1.2 System Overview

The primary objective of the NEXCOM Program is to provide Air Traffic Services the ability to accommodate the growing number of control sectors and communication needs using the available limited frequency spectrum. Principal goals of the system architecture include introduction of a new generation of VHF MDRs and RIUs into the ground facilities supporting air/ground communications, i.e., Remote Center Air/Ground (RCAG), Remote Communications Outlet (RCO) and Remote Transmitter and Receiver (RTR) facilities; support of existing legacy interfaces with Radio Control Equipment (RCE) and Voice Switching and Control Systems (VSCS); and transition to standardized, programmable digital operations for both ground sites and aircraft. The NEXCOM Segment One MDR will also be used to replace the current generation of DSB-AM mode radios to sustain DSB-AM operations at sites outside the NEXCOM Segment One Program.

The NEXCOM system provides voice and data communication exchanges between airborne and ground-based systems. It is an A/G subsystem of the Aeronautical Telecommunications Network (ATN) using the Aeronautical Mobile (Route) Services (AM(R)S) band and it is organized according to the Open System Interconnection (OSI) Model (defined by the International Standards Organization (ISO)). NEXCOM will provide reliable subnetwork services to the ATN systems. For services in addition to DSB-AM voice, the equipment incorporates the two lowest layers of the OSI Model. The

equipment specified here will replace existing DSB-AM transmitters and receivers, and provide Layer 1 and a portion of Layer 2 services of the OSI Model.

> Layer 1 (Physical Layer): Provides transmitter/receiver frequency control, bit exchanges over the radio medium, and notification functions. These functions are referred to as "radio" and "modulation/demodulation" functions. A Differential 8-Phase Shift-Keying (D8PSK) modulation scheme provides a 31.5 kbps bit rate (at Layer 1) for digital voice and data.
>
> Layer 2 (Link Layer): The Link Layer is divided into a Media Access Control (MAC) sublayer, a Data Link Services (DLS) sublayer and a Link Management Entity (LME). The MAC sublayer provides access to the physical layer by a three-or-four slot Time Division Multiple Access (TDMA) algorithm controlling channel access for VDL Mode 3.

The radio equipment will be compatible with VDL Mode 3 specified in RTCA document DO-224a (MASPS). The DSB-AM sections in this document are based upon the existing purchase descriptions FAA-P-2883 and FAA-P-2884.

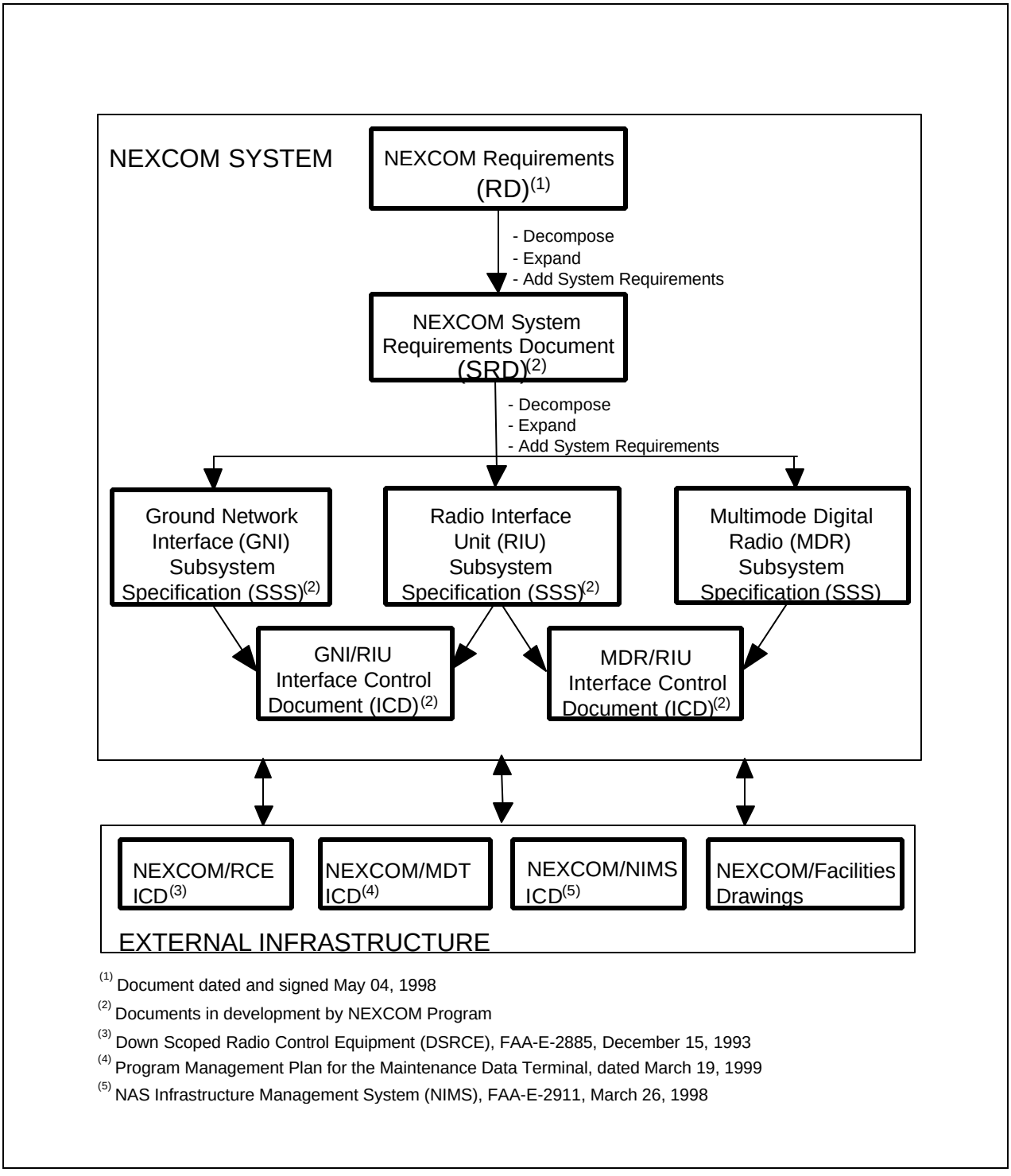
The 25 kHz DSB-AM mode is used for backward compatibility. The MDR needs to be physically compatible with existing equipment. It is meant to provide for digital voice, data, and analog voice communications while using the existing RCE. Technical parameters defining DSB-AM operation at 8.33 kHz channel spacing have been added in Section 32 in this document so that the MDR can operate in the 8.33 kHz International Civil Aviation Organization (ICAO) defined mode. This capability is included as risk mitigation and there are no plans to use this operation in the NAS.

The equipment specified here is a subsystem of the NEXCOM System. Figure 1-1 identifies specifications currently under development. A Ground Network Interface (GNI) subsystem specification may contain requirements for equipment beyond Segment One, which will provide connectivity required for data link routers and their accompanying network services.

The NEXCOM System will be operated and maintained in the same facilities as the existing A/G communication system facilities i.e., RCAG, RCO, RTR, and their control facilities. The NEXCOM equipment will be integrated into these existing facilities as smoothly as possible, replacing the current equipment.

NEXCOM Segment One will replace the current ground-based analog radios at High/Superhigh En-Route facility locations with programmable MDRs and RIUs with an integrated voice encoder (vocoder).

During the initial transition phase of Segment One the MDRs will be operated in the 25 kHz DSB-AM mode used by the legacy radios. NEXCOM MDRs will be required to support A/G communications activities, which include the replacement and expansion of the existing A/G infrastructure using the legacy interface. Existing telecommunications, VSCS, and RCE will remain in operation on all voice channels for the foreseeable future.



(1) Document dated and signed May 04, 1998

(2) Documents in development by NEXCOM Program

(3) Down Scoped Radio Control Equipment (DSRCE), FAA-E-2885, December 15, 1993

(4) Program Management Plan for the Maintenance Data Terminal, dated March 19, 1999

(5) NAS Infrastructure Management System (NIMS), FAA-E-2911, March 26, 1998

Figure 1-1: NEXCOM Document Tree

2.0 APPLICABLE DOCUMENTS

2.1 Government Documents

The following documents form a part of this specification and are applicable to the extent specified here. In case of conflict between the documents referenced here and the contents of this specification, the contents of this specification **shall** take precedence.

2.1.1 Specifications

FAA:

FAA-E-2944	Multimode Digital Radio (MDR) Maintenance Data Terminal (MDT) Maintenance Application Software Requirements Specification, September 20, 2000 DRAFT
FAA-G-2100G	Electronic Equipment, General Requirements, September 28, 1999
FAA-P-2883	Purchase Description, VHF/UHF Air/Ground Radio Communications Receivers, April 14, 1994
FAA-P-2884	Purchase Description, VHF/UHF Air/Ground Radio Communications Transmitters, April 14, 1994

2.1.2 Standards

FAA:

FAA-STD-020B	Grounding, Bonding and Shielding, 1992

Military:

MIL-HDBK-454(1)	General Guidelines for Electronic Equipment, May 28, 1997
MIL-HDBK-470A	Designing and Developing Maintenance Products and Systems, Volume I and Volume II, August 4, 1997
MIL-STD-461E	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference, August 20, 1999
MIL-STD-810F	Environmental Test Methods and Engineering Guidelines, January 1, 2000
MIL-STD-889B	Dissimilar Metals, May 17, 1993

2.1.3 Other Government Documents

FAA:

NAS-IC-41033502	Interface Control Document for Radio Interface Unit/Multimode Digital Radio, September 20, 2000, Version 2.0
NEXCOM RD	Requirements Document for Next Generation Air/Ground Communications System (NEXCOM), Segment 1, May 4, 1998
DOT/FAA/CT-96/1	Human Factors Design Guide for Acquisition of Commercial Off-the-Shelf Subsystems, Non-Developmental Items, and Developmental Systems, January 15, 1996

FCC:

47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations, October 1998
47 CFR Part 87	Aviation Services, October 1998

NIST:

FIPS PUB 140-1	Federal Information Processing Standards Publication, Security Requirements for Cryptographic Modules, National Institute of Standards and Technology, January 11, 1994
FIPS PUB 186-2	Federal Information Processing Standards Publication, Specifications for Digital Signature Standard (DSS), National Institute of Standards and Technology, January 27, 2000

NTIA:

National Telecommunications and Information Administration, Regulations and Procedures for Federal Radio Frequency Management, September 1995 Edition with Revisions for September 1996 and May 1997

2.2 Non-Government Documents

RTCA:

DO-224a	Signal in Space Minimum Aviation System Performance Standards (MASPS) for Advanced VHF Digital Data Communications Including Capability with Digital Voice Technique

EIA:

EIA-310-E	Cabinets, Racks, Panels, and Associated Equipment, March 17, 1999

ETSI:

ETSI Spec. EN-300-676	EMC and Radio Matters (ERM); Hand held, mobile and fixed radio transmitters, receivers and transceivers for VHF aeronautical mobile service using amplitude modulation; Technical characteristics and methods for measurement.

IEEE/ANSI:

C62.31-1987	IEEE Standard Test Specifications for Gas-Tube Surge Protective Devices
C62.36-1994	IEEE Standard Test Method for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits
C62.41-1991	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
C62.47-1992	IEEE Guide on Electrostatic Discharge (ESD): Characterization of the ESD Environment
Std 519-1992	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

ISO/IEC:

ISO/IEC 7498	Information Technology-Open Systems Interconnection-Basic Reference Model, November 1994

2.3 Documentation Sources

2.3.1 FAA Documents

Copies of FAA specifications, standards, and publications may be obtained from the NEXCOM Contracting Officer, FAA, 800 Independence Avenue SW, Washington, DC 20591. Requests should clearly identify the desired material by number and state the intended use of the material. Revision FAA-G-2100G may be downloaded from the FAA at web site http://www.faa.gov/asd/standards/index.htm.

2.3.2 Military and Federal Documents

Single copies of unclassified military and federal specifications, standards, and publications may be obtained by writing the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120 or by calling (215) 697-3321 Monday through Friday, 8:00 a.m. to 4:30 p.m. (EST).

2.3.3 Federal Communications Commission Documents

Copies of 47 CFR, Part 2 and Part 87 may be obtained from the FCC, 445 12th Street, SW, Washington D.C. or by downloading from the FCC web site at www.fcc.gov/oet/info/rules.

2.3.4 Electronic Industries Alliance Documents

Copies of Electronic Industries Alliance (EIA) standards may be obtained from the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201-3834, by calling (703) 907-7500, or through the web site http://www.eia.org.

2.3.5 National Telecommunications and Information Administration Documents

Copies of National Telecommunications and Information Administration (NTIA) materials may be obtained from NTIA, Department of Commerce, 14th Street and Constitution Avenue NW, Washington, DC 20230, by calling (202) 377-1832, or through the web site http://www.ntia.doc.gov.

2.3.6 Reserved

2.3.7 RTCA, Inc. Documents

Copies of RTCA, Inc. documents may be obtained from RTCA, Incorporated, 1140 Connecticut Avenue NW, Suite 1020, Washington, DC 20036, by calling (202) 833-9339, or through the web site http://www.rtca.org.

2.3.8 ASTM Documents

Copies of American Society for Testing and Materials (ASTM) materials may be obtained from the ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, by calling (610) 832-9585, or through the web site http://www.astm.org.

2.3.9 ETSI Documents

Copies of European Telecommunications Standards Institute documents may be obtained from the ETSI Secretariat at F-06921 Sophia Antipolis CEDEX – France by requesting a copy via the ETSI web site secretariat@etsi.fr.

2.3.10 ISO/IEC Documents

Copies of International Standards Organization documents may be obtained from American National Standards Institute, 11 West 42nd Street, 13th floor, New York, NY 10036. Telephone: (212) 642-4900, Telefax: (212) 398-0023, E-mail: info@ansi.org, Web: http://www.ansi.org/ or http://www.iso.ch/.

2.3.11 IEEE/ANSI Documents

Copies of IEEE/ANSI documents may be obtained from IEEE Customer Service, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, or by calling (800) 701-4333 (in U.S. and Canada), or (732) 981-0060 (outside of U.S. and Canada).

2.3.12 NIST Documents

Copies of National Institute of Standards and Technology may be obtained from NIST, 100 Bureau Drive, Gaithersburg, MD 20899-3460, or by calling (301) 975-6478.

3.0 REQUIREMENTS

3.1 Definitions

3.1.1 "Shall"

When used in this specification, the word "**shall**" refers to an explicit requirement of a system component or the complete system. ([1])

3.1.2 "Should"

When used in this specification, the word "*should*" refers to a desired characteristic of a system component or the complete system.

3.1.3 "Will"

When used in this specification, the word "will" provides information for a characteristic of a system component or a complete related system.

3.2 MDR Requirements

The MDR is defined as one radio receiver and one radio transmitter. The system characteristics described here are for ground MDR equipment. Unless otherwise stated, the MDR requirements apply to both MDR receiver and MDR transmitter for:

1) all operational modes of Section 3.2.1.1,
2) the entire frequency range of Section 3.2.1.1.1,
3) the operating conditions of Section 3.4.3.1,
4) all system configurations in VDL Mode 3,
5) Both fixed-tuned and remotely-tunable configurations.

a) The MDR **shall**$_{(1)}$ be implemented as a separate receiver and separate transmitter.
b) Reserved
c) The MDR receiver and MDR transmitter **shall**$_{(613)}$ interface to the Radio Interface Unit (RIU) as defined in NAS-IC-41033502.

3.2.1 MDR Functions and Software Requirements

3.2.1.1 Modes of Operation

[1]In this document the **shalls** have been numbered. Because of editorial rearrangements, additions and deletions of requirements in response to reviews and comments, the **shall** numbers are not consecutive and, if ordered starting with 1, there may be numbers missing.

a) The MDR receivers and transmitters **shall**$_{(2)}$ operate in the ICAO DSB-AM Mode using 25 kHz channel separation.
b) The MDR receivers and transmitters **shall**$_{(3)}$ operate in the ICAO VDL Mode 3 using 25 kHz channel separation.
c) When in the 8 1/3 kHz DSB-AM (voice) mode, the MDR **shall**$_{(4)}$ operate in compliance with ETSI specification EN-300-676, (excluding Sections 4**3** and 5) except where a requirement in this document (MDR SSS FAA-E-2938) conflicts with a requirement in ETSI specification EN-300-676, the more stringent requirement applies.

3.2.1.1.1 Tuning Range and Channel Increments

a) The MDR receivers and transmitters **shall**$_{(5)}$ tune to 25 kHz channels from 112.000 MHz to 136.975 MHz.
b) The MDR receivers and transmitters **shall**$_{(6)}$ have a user selectable lowest tunable frequency between 112.000 MHz and 118.000 MHz that is selectable in 25 kHz steps.
c) Upon initialization (cold start as defined in Section 6.2.13), the **tuned** frequency **shall**$_{(7)}$ default to 118.000 MHz and all control and monitor parameters assume their default values.
d) The MDR equipment **shall**$_{(8)}$ also tune in 8 1/3 kHz **steps**.

Note: Allocation of all or part of the frequency band from 112.000 MHz up to 117.975 MHz is being considered for Aeronautical Mobile Communications.

3.2.1.2 VDL Mode 3 Protocol Services

For definitions of VDL Mode 3 Time Division Multiple Access (TDMA) see RTCA DO-224a (MASPS).
a) The MDR receiver and transmitter **shall**$_{(9)}$ comply with RTCA DO-224a (MASPS).

3.2.1.2.1 VDL Mode 3 Physical Layer

a) VDL Mode 3 **shall**$_{(10)}$ use the Differential 8 Phase Shift Keying (D8PSK) modulation scheme defined in the RTCA VDL Mode 3 MASPS.
b) The VDL Mode 3 symbol rate **shall**$_{(11)}$ be 10,500 symbols/s with a tolerance of ±2 parts per million (ppm), resulting in a nominal data rate of 31,500 bits per second (bps). Table 3-1 shows the RTCA DO-224a (MASPS) references:

Table 3-1: DO-224a (MASPS) References

Paragraph	Reference
3.3.1.2	Modulation scheme
3.3.1.2.1	Data encoding
3.3.1.2.2	Transmitted signal form

3.2.1.2.2 VDL Mode 3 Link Layer

a) The VDL Mode 3 Link Layer **shall**$_{(12)}$ be in accordance with DO-224a (MASPS).

3.2.1.2.2.1 VDL Mode 3 Media Access Control (MAC) Sublayer

The following requirements apply to the MDR receiver and transmitter:

a) The MAC sublayer of the MDR receiver and transmitter **shall**$_{(13)}$ be as defined in the RTCA DO-224a (MASPS).

3.2.1.2.2.2 External Time Reference

a) The MDR **shall**$_{(14)}$ use the timing reference provided by the RIU as the basis for the frame timing for VDL Mode 3.

3.2.1.2.2.3 Logical Burst Access Channels (LBACs) for the Transmitter

a) The MDR transmitter **shall**$_{(15)}$ transmit VDL Mode 3 bursts received from the RIU based on the Time of Transmission (TOT) field of the Voice, Data, and Management burst (v-burst, D-burst, M-burst) messages as defined in NAS-IC-41033502.
b) The MDR **shall**$_{(16)}$ use the TOT field as the time offset from the start of the VDL Mode 3 6-second epoch (measured in 1/16th of a D8PSK symbol period, the symbol period being 95.24 μsec) to initiate the transmission of the burst. The TOT indicates where the center of the first symbol of the synchronization sequence is to be located in time relative to the start of the VDL Mode 3 6-second epoch.

3.2.1.2.2.4 LBACs for the MDR Receiver

a) The MDR receiver **shall**$_{(397)}$ use the Time of Arrival (TOA) field to indicate the time offset from the beginning of the VDL Mode 3 6-second epoch where the center of the first symbol of the synchronization sequence occurred for received bursts.
b) Reserved
c) The MDR receiver **shall**$_{(399)}$ search for VDL Mode 3 synchronization signals using the Sync Search Control message parameters received from the RIU to determine the type of VDL Mode 3 synchronizaton sequence(s) to search for (STYPE field) as specified in the Table below, and the time window in which to search for the specified synchronization sequence(s) using the S_START and S_STOP fields.
d) The MDR Receiver **shall**$_{(705)}$ demodulate and report a total of five 96-bit vocoder frame segments to the RIU if the message ID (MID) field in the voice header indicates a TS2 voice transmission.

Note 1: For STYPE=0, a single correlation process may be used to search for S_1 and S_{1*} simultaneously, since the phase change sequences they imply differ by exactly 180 degrees/symbol. The Sync Search Control message is to be treated as a single instance reservation and will need to be refreshed for each epoch.
Note 2: It is not the intent that Sync Searches will overlap and thereby require the ability to simultaneously search for different synchronization sequences outside of STYPE 0.
Note 3: It is allowable for vendors to restrict the buffering of Sync Search Control messages so that the RIU is required to send Sync Search Control messages no more than one or two

MAC cycles before their applicability instead of requiring the MDR to buffer messages for the entire epoch
Note 4: For TS2 voice bursts, each 20ms segment of vocoder speech is encoded in 80-bit frames and the voice data is organized in 96-bit segments over the T1 interface to conform with the Voice-Burst Message format as defined in NAS-IC-41033502.

Table 3-1A: MDR Receiver Synchronization Sequences

STYPE	Search for:
0	S_1 and S_{1*}
1	Reserved
2	S_2
3	S_{2*}

e) The MDR receiver **shall**$_{(623)}$ declare synchronization in VDL Mode 3 when the center of the first D8PSK symbol in the matching synchronization sequence falls within the time window specified by the S_START and S_STOP fields of the Sync Search Control message.
f) After achieving VDL Mode 3 synchronization within the time window specified in the Sync Search Control message, the MDR receiver **shall**$_{(624)}$ demodulate and decode the number of Golay words (24,12) Golay words (Number of Golay Words (NGW) as specified in Sync Search Control message), and demodulate all remaining D8PSK data (for Voice or Data bursts, V/D-bursts) in the received burst.
g) After achieving VDL Mode 3 synchronization with STYPE=2 (V/D-burst), the MDR receiver **shall**$_{(625)}$ decode the voice/data header Message ID field and report the voice/data header, Golay error count, Time of Arrival (TOA), received power level and remaining D8PSK data in the burst to the RIU using the V-burst message (if Message ID = 0-3) or D-burst message (if Message ID=3-7) in accordance with the HDLC message timing rules specified in Section 3.2.1.6.6 and the V/D-burst message formats defined in NAS-IC-41033502.
h) After achieving VDL Mode 3 synchronization with S_1, S_{1*} or S_{2*} (M-burst), the MDR receiver **shall**$_{(626)}$ report the sync type (STYPE), Time of Arrival (TOA), Golay error counts, received power level and decoded Golay words to the RIU using the M-burst message in accordance with the HDLC message timing rules specified in Section 3.2.1.6.6 and the M-burst message format defined in NAS-IC-41033502.

3.2.1.3 DSB-AM Protocol Services

3.2.1.3.1 Physical Layer

a) The modulation method **shall**$_{(17)}$ be DSB-AM in accordance with the CFR 47, Part 2 and Part 87 and the NTIA, Regulations and Procedures for Federal Radio Frequency Management (Chapter 6, paragraph 6.3).

3.2.1.4 Software and Processor Requirements

a) The equipment **shall**$_{(18)}$ be reconfigurable to allow the MDR receiver and transmitter to operate in the known ICAO standardized communication waveforms (i.e., 25 kHz DSB-AM, 8.33 kHz DSB-AM, and VDL Mode 3).
b) Protocols and user access/synchronization schemes in the equipment **shall**$_{(19)}$ be programmable.

Note: The purpose of requiring programmability is to allow ease of changes as MASPS requirements are further refined/defined, and to allow implementation of future capabilities as the NEXCOM System evolves to meet NAS needs.

c) The MDR receiver and transmitter equipment, as separate entities, **shall**$_{(20)}$ use no more than 50 percent of their non-volatile memory (as defined in Section 6.2.16) or storage, under worst-case conditions.
d) The MDR receiver and transmitter, as separate entities, **shall**$_{(21)}$ use no more than 50 percent of their Random Access Memory (RAM), under worst-case conditions (e.g., when the MDR has both the software-in-use and a second software version loaded).
e) The processor utilization of the MDR receiver and transmitter, as separate entities, **shall**$_{(22)}$ peak at 50 percent or less.
f) The equipment **shall**$_{(23)}$ be able to accurately process dates in data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations.
g) If the MDR does not successfully restart after receipt and execution of the Switch Software Version control parameter command, the MDR receiver and transmitter **shall**$_{(24)}$ revert to the previous version of software and restart.
h) If the Software upload is rejected, either by failed **error-checking** or incorrect authentication, the MDR **shall**$_{(571)}$ send a Control reply (RR=0) message containing a Software Upload Enable/Disable parameter indicating DISABLE_UPLOAD and an error code indicating the reason for rejection.

3.2.1.5 MDR State and State Transition Requirements

a) The MDR **shall**$_{(533)}$ have the following states: Off, Power Up, Offline, Online, Recovery, Failed and Power Down (if exercised), as defined in Section 6.2.15.
b) The MDR **shall**$_{(534)}$ provide visual indication of the MDR state on the MDR front panel.

Note: For the definition of critical and non-critical equipment failures see Section 6.2.17.

3.2.1.5.1 State Transition

a) The MDR **shall**$_{(536)}$ transition from state to state in accordance with Section 6, Table 6-1, and Figure 6-2, as applicable.

3.2.1.5.2 Off State

a) When in the OFF state, the MDR transmitter **shall**$_{(537)}$ not transmit.
b) When in the OFF state, the MDR receiver **shall**$_{(538)}$ not generate any form of audio output.
c) When AC or DC power is present at the MDR power input and the MDR Power Switch(es) are on (i.e., not in the Off state), the MDR **shall**$_{(539)}$ provide visual indication of power.

3.2.1.5.3 Power Up State

a) When in the Power Up state,
   1) the MDR transmitter **shall**$_{(540)}$ not transmit.
   2) the MDR receiver **shall**$_{(541)}$ not generate any form of audio output.
b) The time between application/restoral of power to the MDR and the MDR's transition out of the Power Up state **shall**$_{(542)}$ not exceed 30 seconds.
c) The MDR **shall**$_{(543)}$ conduct and complete Power On Self Test functions in the Power Up state.
d) If the MDR was in Online state prior to the most recent Powerdown/Off state, upon completion of the Power Up sequence, the MDR **shall**$_{(544)}$ transition from Power Up state to Online state.
e) If the MDR was in Offline state prior to the most recent Powerdown/Off state, upon completion of the Power Up sequence, the MDR **shall**$_{(545)}$ transition from Power Up state to Offline state.

3.2.1.5.4 Off Line State

a) When in Offline state, the remote analog audio and remote discrete Push-to-Talk (PTT) input of the MDR **shall**$_{(546)}$ be disabled.
b) When in Offline state, the digital, local analog audio, and local PTT inputs of the MDR transmitter **shall**$_{(547)}$ be enabled.

3.2.1.5.5 On Line State

a) When in Online state, the MDR **shall**$_{(550)}$ enable all functions, process control parameter commands in accordance with Section 3.2.3.2, and disable local user (technician) analog audio input and local user PTT input when the remote user PTT (or audio equivalent) is active.

3.2.1.5.6 Recovery State

a) The MDR **shall**$_{(553)}$ enter the Recovery state when the MDR detects a potentially recoverable failure.
b) Potentially recoverable failures **shall**$_{(554)}$ include, but not be limited to, over-temperature conditions and RIU timing offset slip.
c) When in Recovery State, the MDR transmitter **shall**$_{(555)}$ not transmit.
d) When in Recovery state, the MDR receiver **shall**$_{(556)}$ not generate any form of audio output.
e) The MDR **shall**$_{(557)}$ transition from the Recovery state to the previous state if the recovery process has been successful (e.g., the recoverable fault was eliminated).
f) The MDR **shall**$_{(558)}$ transition from the Recovery state to the Failed state if the recovery process was not successful (e.g., the potentially recoverable fault could not be eliminated).

3.2.1.5.7 Failed State

a) When in Failed state,
   1) the MDR transmitter **shall**$_{(559)}$ not transmit.
   2) the MDR receiver **shall**$_{(560)}$ not generate any form of audio output
   3) the MDR **shall**$_{(561)}$ enable only those control commands that can be executed accurately.

b) The MDR **shall**$_{(562)}$ transition to the Failed state if the MDR detects an unrecoverable failure, defined as a failure that a local user (technician) cannot eliminate from outside the MDR.

3.2.1.5.8 Power Down State

a) If the MDR employs a Power Down state, then when in Power Down state,
   1) the MDR transmitter **shall**$_{(563)}$ not transmit.
   2) the MDR receiver **shall**$_{(564)}$ not generate any form of audio output.
   3) all MDR functions **shall**$_{(565)}$ be disabled, except logging/reporting and front panel indication.
   4) the MDR **shall**$_{(566)}$ provide visual indication on the front panel that the MDR is ready for transition to Off state.

b) If the Power Down state is implemented, the MDR **shall**$_{(567)}$ accept the control parameter to transition to the Power Down State (ID#5 "MDR State" with value "Power Down") only from the MDT port.

3.2.1.6 MDR/RIU Data Link Layer

3.2.1.6.1 High Level Data Link Control (HDLC) Frame Structure

a) The MDR **shall**$_{(400)}$ support the HDLC Frame Structure as defined in NAS-IC-41033502.

3.2.1.6.2 Link Control

a) The MDR **shall**$_{(401)}$ support the link initialization procedures defined in NAS-IC-41033502.
b) The MDR **shall**$_{(402)}$ provide the means to clear the link at any time, in accordance with NAS-IC-41033502.
c) While in the *link **in**active* state, the MDR **shall**$_{(701)}$ ignore all UI-frame-based messages that are not MDR/RIU Status messages.

3.2.1.6.2.1 MDR Receiver Frame Priority

a) The MDR receiver **shall**$_{(635)}$ give priority to the transmission of Voice and PCM Voice messages, such that they are to be the next frame transmitted upon the data being received and formatted into an HDLC frame.
b) The MDR receiver **shall**$_{(636)}$ give priority to the transmission of Management and Data messages over Monitoring and Control response messages.

3.2.1.6.3 Link Level Parameters

a) The MDR **shall**$_{(403)}$ limit the size of HDLC frames across the MDR/RIU link according to the N1 parameter in accordance with NAS-IC-41033502.
b) The MDR **shall**$_{(572)}$ discard clearing TEST response frames after the expiration of the T1 timer in accordance with NAS-IC-41033502.
c) The MDR **shall**$_{(573)}$ retransmit a clearing TEST command frame upon expiration of the T2 timer in accordance with NAS-IC-40233502.
d) The MDR **shall**$_{(574)}$ reject Control and Monitoring message segments received after expiration of the T3 timer in accordance with NAS-IC-40233502.

3.2.1.6.4 HDLC Frame Timing

a) The MDR **shall**$_{(404)}$ support the timing and size of HDLC frame transmissions between the MDR and RIU, in accordance with NAS-IC-41033502.

3.2.1.6.5 Link Level Message Description

a) The MDR **shall**$_{(405)}$ support the Link Level Message Structure between the MDR and RIU, in accordance with NAS-IC-41033502.

3.2.1.6.5.1 General Message Structure

a) The MDR **shall**$_{(406)}$ support the General Message Structure between the MDR and RIU, in accordance with NAS-IC-41033502.
b) The MDR **shall**$_{(407)}$ support the message types and message IDs, as defined in Table 3-1B below:

Table 3-1B: Message Identification

Message ID	Message Type
0	Voice-Burst (V-Burst)
1	Data-Burst (D-Burst)
2	Management-Burst (M-Burst)
3	Sync Search Control
4	PCM Voice
5	Radio Control
6	Radio Monitoring
7	RIU/MDR Status
8-255	Reserved

c) The MDR **shall**$_{(408)}$ support the field descriptions and message encoding, as defined in NAS-IC-41033502, for each of the message types identified in the Table above.

3.2.1.6.5.1.1 Voice-Burst (V-Burst) Message

a) The MDR transmitter **shall**$_{(568)}$ receive V-burst messages from the RIU (Message ID = 0), encoded as defined in NAS-IC-41033502.

b) The MDR receiver **shall**$_{(627)}$ send V-burst messages to the RIU (Message ID = 0), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.2 Data-Burst (D-Burst) Message

a) The MDR transmitter **shall**$_{(409)}$ receive D-burst messages from the RIU (Message ID = 1), encoded as defined in NAS-IC-41033502.
b) The MDR receiver **shall**$_{(628)}$ send D-burst messages to the RIU (Message ID = 1), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.3 Management-Burst (M-Burst) Message

a) The MDR transmitter **shall**$_{(410)}$ receive M-burst messages from the RIU (Message ID = 2), encoded as defined in NAS-IC-41033502.
b) The MDR receiver **shall**$_{(629)}$ send M-burst messages to the RIU (Message ID = 2), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.4 Sync Search Control Message

a) The MDR receiver **shall**$_{(411)}$ receive sync search control messages from the RIU (Message ID = 3), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.5 PCM-Voice Message

a) The MDR transmitter **shall**$_{(412)}$ receive PCM-Voice messages from the RIU (Message ID = 4), encoded as defined in NAS-IC-41033502.
b) The MDR receiver **shall**$_{(630)}$ send PCM-Voice messages to the RIU (Message ID = 4), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.6 Radio Control Message

a) The MDR **shall**$_{(413)}$ receive radio control messages from the RIU (Message ID = 5), and respond with messages encoded as defined in NAS-IC-41033502.
b) The MDR **shall**$_{(614)}$ report errors with radio control messages in accordance with NAS-IC-41033502.

3.2.1.6.5.1.7 Radio Monitoring Message

a) The MDR **shall**$_{(414)}$ send radio monitoring messages to the RIU (Message ID = 6), encoded as defined in NAS-IC-41033502.

3.2.1.6.5.1.8 RIU/MDR Status Message

a) The MDR **shall**$_{(415)}$ send/receive RIU/MDR status messages to/from the RIU (Message ID = 7), encoded as defined in NAS-IC-41033502.
b) The RIU/MDR status message **shall**$_{(416)}$ **report** the status of the MDR or be used by the RIU to complete the link initialization.

3.2.1.6.6 MDR Receiver HDLC Message Timing

a) For the first vocoder frame in a VDL Mode 3 received burst (VFSN=1), the V-burst HDLC message **shall**$_{(417)}$ have the LEN field set to 96.

b) For VFSN=1, the MDR receiver **shall**$_{(418)}$ complete transmission of the V-burst message HDLC end FLAG no later than time:

$$T_{RXV1} = \frac{\left(\frac{TOA}{16} + 55.5\right)}{10{,}500} + T_{MP} + 0.00343 \text{ seconds},$$

where T_{RXV1} is the time offset measured from the start of the 6-second VDL epoch in which the burst was received, TOA is the Time of Arrival as specified in the V-burst message header, and T_{MP} is the maximum MDR receiver processing time as specified by the MDR manufacturer with T_{MP} < 8 milliseconds. T_{MP} is defined as the time it takes the MDR receiver to demodulate and Golay decode a V-burst header (8 D8PSK symbols), demodulate the first vocoder frame (32 D8PSK symbols) and format a V-burst HDLC message for transmission to the RIU.

c) The MDR Receiver **shall**$_{(419)}$ send the vocoder frames to the RIU in the order in which they are demodulated.

d) The MDR Receiver **shall**$_{(420)}$ complete transmission of the HDLC end FLAG for the V-burst message that contains vocoder frame 6 no later than time:

$$T_{RXV2\text{-}6} = \frac{\left(\frac{TOA}{16} + 55.5\right)}{10{,}500} + 0.030 \text{ seconds},$$

where $T_{RXV2\text{-}6}$ is the time offset measured from the start of the 6-second VDL epoch in which the burst was received, and TOA is the Time of Arrival as specified in the V-burst message header.

e) Reserved

f) The MDR receiver **shall**$_{(422)}$ complete transmission of the M-Burst message HDLC end FLAG no later than 30 milliseconds after the TOA as specified in the M-burst message header.

g) The MDR Receiver **shall**$_{(423)}$ send the data segments to the RIU in the order in which they are demodulated.

h) Reserved

i) The MDR receiver **shall**$_{(425)}$ complete transmission of the D-burst message HDLC end FLAG for the last D-burst message segment in a D-burst no later than 30 milliseconds after the TOA as specified in the D-burst message header.

3.2.1.6.7 MDR Transmitter Received HDLC Message Timing

In VDL Mode 3, the RIU will be required to deliver V-burst, D-burst and M-burst messages to an MDR transmitter over the T1 link far enough in advance to allow sufficient processing time in the MDR prior to ramp-up or continuation of D8PSK modulation. The RIU will not send any V-burst, D-burst

or M-burst message to the MDR more than 240 milliseconds prior to Time of Transmission (TOT) specified in the message header.

a) The MDR manufacturer **shall(637)** specify message timing parameters T_{M1} through T_{M5} as defined in the Table 3-1C below:

Table 3-1C: MDR Transmitter Voice, Data and Management Message Timing Parameters

From time of receipt of HDLC END flag in RIU message:	To	MDR Message Timing Parameter	Absolute Maximum (milliseconds)
V-burst (VFSN=1)	Start of V-burst ramp-up	T_{M1}	8.5
V-burst (VFSN=2-5)	Start of modulation of 1st D8PSK symbol in message	T_{M2}	8.5
V-burst (VFSN=6)	Start of modulation of 1st D8PSK symbol in message	T_{M3}	6.0
D-burst (containing 6th data segment)	Start of D-burst ramp-up	T_{M4}	30.0
M-burst	Start of M-burst ramp-up	T_{M5}	90.0

b) Message timing parameters T_{M1} through T_{M5} **shall(638)** not exceed the absolute maximum values shown in the Table defined in Section 3.2.1.6.7a.

c) When the MDR is in the Online state in VDL Mode 3 and a V-burst message, D-burst or M-burst message is received from the RIU in accordance with timing parameters T_{M1}-T_{M5}, the MDR **shall(639)** begin D8PSK modulation of the burst ramp-up at time:

$$\left[\frac{\frac{TOT}{16} - 5.5}{10{,}500}\right] \pm 11.9 * (1E-06) \quad \text{Seconds}$$

where TOT is the Time of Transmission of the VDL Mode 3 burst relative to the VDL Mode 3 6-second time epoch as specified in the V-burst, D-burst or M-burst message.

d) When the MDR is in the Online state in VDL Mode 3 and RF transmission of a V-burst, D-burst or M-burst has commenced, and the V-burst, D-burst or M-burst message(s) associated with the transmitted burst are received from the RIU in accordance with message timing parameters T_{M1} through T_{M5}, the MDR **shall(640)** perform continuous D8PSK modulation for the duration of the burst using data contained in the V-burst, D-burst or M-burst message.

3.2.1.6.8 MDR Transmitter Received HDLC Message Sequencing

a) If the MDR is unable to complete processing of the first segment of a V-burst message (VFSN=1 in message header) in time to begin modulation at the time specified in Section 3.2.1.6.7c, the MDR

shall$_{(641)}$ discard the V-burst message and all remaining V-burst message segments associated with that V-burst, refrain from modulating the V-burst, and set the corresponding "V" underflow bit in the next RIU/MDR Status message that is sent to the RIU.

b) When the MDR has commenced modulation of a V-burst and a V-burst message that contains voice segment 2, 3, 4 or 5 is not received in accordance with timing parameter $T_{M2,}$ or a V-burst message that contains voice segment 6 is not received in accordance with timing parameter T_{M3}, the MDR **shall**$_{(642)}$ continue V-burst modulation by repeating the data from the last valid voice frame received from the RIU and set the "V" underflow bit in the next RIU/MDR Status message that is sent to the RIU.

c) If any of the six message segments in a D-burst are missing or received in error or received out of sequence, the MDR **shall**$_{(643)}$ discard all message segments associated with the D-burst and refrain from modulating the D-burst.

d) If the MDR is unable to complete D-burst message processing in time to begin modulation at the time specified in 3.2.1.6.7c, the MDR **shall**$_{(644)}$ discard the D-burst message and all D-burst message segments associated with that D-burst, refrain from modulating the D-burst, and set the corresponding "D" underflow bit in the next RIU/MDR Status message that is sent to the RIU.

e) If the MDR is unable to complete M-burst message processing in time to begin modulation at the time specified in 3.2.1.6.7c, the MDR **shall**$_{(645)}$ discard the M-burst message, refrain from modulating the M-burst, and set the corresponding "M" underflow bit in the next RIU/MDR Status message that is sent to the RIU.

f) A Monitoring or Control message **shall**$_{(646)}$ be deemed valid by the MDR transmitter if all segments of the message are received in sequence prior to the expiration of the T3 timer.

g) For Monitoring or Control messages, if any message segment is received out of order, or if the T3 timer expires prior to the receipt of all message segments, all of the message segments **shall**$_{(647)}$ be discarded.

3.2.1.7 MDR/RIU Physical Layer

a) The MDR **shall**$_{(426)}$ support the fractional T1 protocol as defined in NAS-IC-41033502.

3.2.1.7.1 T1 Time Slot Assignments

a) The MDR **shall**$_{(427)}$ be configurable to use any one of the five data channels plus the timing channel (slots 1 and 2), in accordance with NAS-IC-41033502.

b) On receipt of an HDLC Channel Number control message, the control response **shall**$_{(702)}$ be sent back on the original HDLC Channel.

c) After a successful response to the HDLC Channel Number control message has been sent, the MDR **shall**$_{(4703}$ clear the RIU link on the original HDLC channel, begin receiving on the new HDLC channel and await the RIU's establishment of a new link on the new channel per NAS-IC-41033502

3.2.1.7.2 T1 Time Slots – Timing Channel

a) The MDR **shall**$_{(428)}$ support the characteristics of the T1 Timing Channel, in accordance with NAS-IC-41033502.
b) The MDR **shall**$_{(429)}$ loop-back to the RIU the information contained in the Timing Channel every T1 frame to allow the RIU to measure the round trip time delay through the telecommunications path between the RIU and MDR.
c) The looped back Timing Channel **shall**$_{(430)}$ be delayed in the MDR by a constant time T_{TCL} ±10 microsecond tolerance, where $T_{TCL} \leq 1$ millisecond.
d) Reserved
e) The MDR **shall**$_{(432)}$ derive all necessary VDL Mode 3 TDMA timing information using the Timing Channel, T1 frame timing, and the MAC Timing Offset Correction messages provided by the RIU.
f) The MDR **shall**$_{(433)}$ incorporate the necessary corrections to compensate for internal delays within the radio (e.g., processing delays, FIR filter delays, modulation delays, demodulation delays).
g) In remote connections using asynchronous clocks, there exists the possibility that the elastic stores will repeat, or skip a frame, to accommodate clock slippage. The MDR **shall**$_{(434)}$ detect this error condition and report it to the RIU.

3.2.2 Performance Requirements

3.2.2.1 MDR Receiver Requirements

3.2.2.1.1 Receiver Digital and Audio Interfaces

a) Reserved

3.2.2.1.1.1 VDL Mode 3

a) The digital interface **shall**$_{(27)}$ carry digitized voice with time-multiplexed user data, control signals, and timing signals, and RMMC information between the receiver and the RIU.

Note: There is no provision for local audio in VDL Mode 3.

3.2.2.1.1.2 DSB-AM

a) The MDR receiver **shall**$_{(29)}$ provide a main audio output to the RCE connector on the rear of the receiver (See Section 3.3.1.3).
b) There **shall**$_{(31)}$ be a local audio output terminated in a headset/headphone jack located on the front panel of the receiver. (See Section 3.3.1.5.)
c) The (front panel) local audio output **shall**$_{(673)}$ be active whether the MDR receiver is generating analog audio output or PCM audio output.
d) The main and local audio outputs **shall**$_{(30)}$ have a balanced 600 ohms (±10 percent) output impedance.
e) The main audio level **shall**$_{(26)}$ be controllable both locally from the MDT and remotely via the RIU.
f) The output level of the local headset/headphone **shall**$_{(32)}$ be controllable from the front panel independent of the main audio level control.

3.2.2.1.1.2.1 DSB-AM PCM Voice Reception

a) The MDR receiver **shall**$_{(435)}$ convert demodulated DSB-AM audio to linear Pulse Code Modulation (PCM) at a sampling rate of 8,000 16-bit PCM samples per second with a maximum quantization level corresponding with 100 percent DSB-AM modulation level and send PCM messages to the RIU over the T1 link.

b) The format of the PCM messages sent to the RIU **shall**$_{(436)}$ be as specified in NAS-IC-41033502.

c) With the exception of the last PCM voice packet in a voice reception, all PCM voice packets sent to the RIU **shall**$_{(438)}$ contain the same number of 16-bit linear PCM samples, N_{PCM}, where: $120 \leq N_{PCM} \leq 200$.

d) The last PCM voice packet in a voice reception sent to the RIU **shall**$_{(439)}$ contain less than or equal to N_{PCM} linear PCM samples.

e) For N=1 and N=2, the MDR receiver **shall**$_{(440)}$ complete transmission of the HDLC end FLAG for the Nth PCM message in a downlink DSB-AM voice reception no later than $0.0075 + [(N+1) * T_{VF}]$ seconds after squelch break, where:

N = PCM message number since squelch break; N = 1,2,3…

T_{VF} = K/8,000 seconds, and

K = number of PCM samples in the N^{th} PCM message (LEN field/16).

f) For N>2, the MDR receiver **shall**$_{(441)}$ complete transmission of the HDLC end FLAG for the Nth PCM message in a downlink DSB-AM voice reception no later than $0.0075 + [(N-2) * T_{VF}]$ seconds after the HDLC end Flag for the 2^{nd} PCM message (N=2) has been transmitted over the T1 link, where:

N = PCM message number since squelch break; N = 3,4,5…

T_{VF} = K/8,000 seconds, and

K = number of PCM samples in the N^{th} PCM message (LEN field/16).

g) For PCM messages, the N1 parameter does not apply and the maximum number of information bits **shall**$_{(442)}$ be limited to 3,264.

3.2.2.1.2 Uncorrected Bit Error Rate (BER)

3.2.2.1.2.1 VDL Mode 3

a) The uncorrected BER performance of equal to or better than 10^{-3} **shall**$_{(33)}$ be achieved under the conditions specified in Sections 3.2.2.1.3, 3.2.2.1.7, 3.2.2.1.17 through 3.2.2.1.22 and 3.2.2.1.25.

Note: An external test set, which is not part of the MDR, may generate a test sequence for the desired signal, add appropriate training sequences and map the resulting test sequence directly into the VDL Mode 3 frame structure without bit scrambling. The test set will also include other transmitter functions to generate appropriate VDL Mode 3 RF signals at the desired channel frequency. These RF test signals combined with the undesired signals (also

generated by the test set) will be input to the MDR receiver under test for uncorrected BER measurement.

3.2.2.1.2.2 DSB-AM

Not Applicable.

3.2.2.1.3 Receiver Sensitivity

a) The MDR receiver RF input **shall**$_{(367)}$ have a 50 ohm characteristic impedance.
b) The sensitivity values **shall**$_{(679)}$ be achieved with the MDR in the remotely tuned configuration or the fixed tuned configuration.

3.2.2.1.3.1 VDL Mode 3

a) In the absence of added external noise, the specified uncorrected BER (See Section 3.2.2.1.2.1) **shall**$_{(36)}$ be achieved with a -100 dBm VDL Mode 3 signal at the MDR receiver antenna RF input.

3.2.2.1.3.2 DSB-AM

a) The MDR receiver **shall**$_{(37)}$ produce a SINAD (ratio of (Signal plus Noise plus Distortion) to (Noise plus Distortion)) of 10 dB or greater at the main and local audio outputs when an RF signal of no more than -102 dBm (modulated at 30 percent with a 1004 Hz tone) is present at the MDR RF input.

3.2.2.1.4 Receiver Rejection of Signals Inside the VHF Band

See Section 3.2.2.1.18.

3.2.2.1.5 Receiver Selectivity

VDL Mode 3 and DSB-AM

a) The selectivity of the MDR receiver **shall**$_{(38)}$ conform to Table 3-2 with respect to the tuned channel center frequency across the entire frequency band:

Table 3-2: Selectivity Profile

Level	VDL Mode 3 and DSB-AM Bandwidth(25 kHz Ch.)	DSB-AM Bandwidth(8.33 kHz Ch.)
- 6.0 dB	± 9 kHz Minimum	± 3.5 kHz Minimum
- 60.0 dB	± 25 kHz Maximum	± 8.33 kHz Maximum
- 80.0 dB	± 50 kHz Maximum	± 25 kHz Maximum

3.2.2.1.6 Receiver Image Rejection

VDL Mode 3 and DSB-AM

a) There **shall**$_{(39)}$ be no image frequencies within the 112.000 MHz to 136.975 MHz frequency band.

b) The sensitivity requirements of Section 3.2.2.1.3 **shall**$_{(40)}$ not be degraded more than 3 dB in the presence of an unmodulated carrier for all spurious response frequencies (including the receiver image frequency) applied to the MDR RF input at a level 80 dB above the desired signal.

Note: Collocation tests will not be conducted where the frequency of the interfering signal is coincidental with a known spurious response frequency.

3.2.2.1.7 Receiver Distortions

3.2.2.1.7.1 Receiver Intermodulation

VDL Mode 3 and DSB-AM

a) The sensitivity requirements defined in 3.2.2.1.3 **shall**$_{(41)}$ not be degraded by more than 3 dB in the presence of two –5 dBm interfering signals, both FM modulated with a 400 Hz tone 75 kHz deviation, with the interfering frequencies chosen in the 87.5 MHz to 107.9 MHz range, such that one of the 3rd order products is located on the chosen receive frequency.
b) In addition, the sensitivity requirements defined in 3.2.2.1.3 *should* not be degraded by more than 3 dB in the presence of two +5 dBm interfering signals, one FM modulated with a 400 Hz tone at 75 kHz deviation and the other interferer a continuous wave (CW) signal, with the interfering frequencies chosen in the 87.5 MHz to 107.9 MHz range, such that one of the 3rd order products is located on the chosen receive frequency.
c) The sensitivity requirements defined in Section 3.2.2.1.3 **shall**$_{(42)}$ not be degraded by more than 3 dB in the presence of two –30 dBm interfering signals 90 percent AM modulated with a 400 Hz tone, in the 112.000 MHz to 136.975 MHz band, with the frequencies of the interfering signals offset from the desired channel by +2.0 MHz and +4.0 MHz, or –2.0 MHz and –4.0 MHz, respectively.

3.2.2.1.7.2 Cross Modulation

3.2.2.1.7.2.1 VDL Mode 3

Not Applicable.

3.2.2.1.7.2.2 DSB-AM

a) An on-channel signal (modulated 30 percent with a 1004 Hz tone) adjusted to produce a 10.0 dB SINAD ratio, **shall**$_{(43)}$ produce not less than 8.0 dB SINAD ratio in the presence of an off-channel signal modulated 30 percent with a 400 Hz tone as defined below:
   1) An off-channel signal separated from the desired on-channel signal by ± 0.5 MHz, at a level 70.0 dB above the desired signal.
   2) An off-channel signal separated from the desired on-channel signal by ± 1.0 MHz, at a level 75.0 dB above the desired signal.

3) An off-channel signal separated from the desired on-channel signal by ± 1.5 MHz, at a level 80.0 dB above the desired signal.

3.2.2.1.8 Receiver Frequency Tolerance

VDL Mode 3 and DSB-AM

a) The frequency tolerance of the receiver reference frequency **shall**$_{(47)}$ be within ± 0.0001 percent (± 1 ppm) of its reference value for a period of one year following alignment over the full frequency range specified in Section 3.2.1.1.1, and the temperature range specified in Section 3.4.3.1.
b) The reference used to generate the receiver operating frequency **shall**$_{(444)}$ have a tuning adjustment to compensate for aging during the operational life of the equipment.
c) The receiver operating frequency **shall**$_{(446)}$ be adjustable to within ± 1 ppm of the tuned channel center frequency.
d) The MDR receiver **shall**$_{(650)}$ provide an output of the reference frequency signal on the front panel for measurement, testing and alignment.
e) An external reference frequency monitor port **shall**$_{(651)}$ be provided with the following characteristics:
   1) Impedance: 50 Ohm
   2) REF FREQ Signal Level: 0 dBm (±3 dB)
f) The REF FREQ monitor port **shall**$_{(652)}$ be sufficiently isolated such that a short circuit applied from the monitor port to ground does not degrade the MDR performance.

3.2.2.1.9 Receiver Audio Output Control

a) With an RF input consisting of a -87 dBm carrier AM modulated 30 percent with a 1004 Hz tone, the main audio output level of the MDR receiver **shall**$_{(48)}$ be adjustable between -25 dBm and +20 dBm in 0.5 dB steps.
b) With an RF input consisting of a -87 dBm carrier AM modulated 30 percent with a 1004 Hz tone, the front panel headphone jack audio level **shall** $_{(368)}$ be continuously adjustable with the front panel volume control from –25 dBm to +20 dBm.

3.2.2.1.10 Receiver Audio Level Regulation

3.2.2.1.10.1 VDL Mode 3

Not Applicable.

3.2.2.1.10.2 DSB-AM

a) With an RF input signal of -87 dBm (modulated 30 percent with a 1004 Hz tone) and the receiver adjusted for an audio output level of +20 dBm, the audio signal **shall**$_{(49)}$ not vary more than ± 1.0 dB as the modulation is increased to 100 percent.
b) With an initial audio output of +20 dBm into a 600 ohm load resistance at the main audio output, the audio output **shall**$_{(50)}$ not drop more than 4.0 dB with a reduction of the load resistance to 120 ohms.

3.2.2.1.11 Receiver Audio Automatic Level Stabilization

3.2.2.1.11.1 VDL Mode 3

Not Applicable.

3.2.2.1.11.2 DSB-AM

a) With a -50 dBm RF input signal modulated 30 percent with a 1004 Hz tone as a reference, the audio output of the receiver **shall**$_{(51)}$ not vary by more than ± 3 dB from the reference level when the reference RF input signal is varied in level between -95 dBm and -7 dBm.

3.2.2.1.12 Receiver Audio Mute and Attenuation

3.2.2.1.12.1 VDL Mode 3

Not Applicable.

3.2.2.1.12.2 DSB-AM

a) The MDR receiver **shall**$_{(52)}$ have a control input and analog input for muting the receiver main audio output.
b) Muting **shall**$_{(53)}$ be activated or deactivated via the MDT and/or RIU, or from an analog source.
c) The muting function attenuation **shall**$_{(54)}$ be selectable from 0 dB (no mute), 15 dB, 20 dB, or no audio (infinite attenuation).
d) The tolerances for the selectable attenuation **shall**$_{(55)}$ be ±3 dB.
e) The default **shall**$_{(56)}$ be no audio.
f) The MDR receiver **shall**$_{(670)}$ mute audio when either the control parameter ID#11 or the input from the Receiver Remote connector (RCE) indicate audio muting, and unmute when both indicate no mute.
g) The MDR receiver **shall**$_{(696)}$ provide a confirmation signal via the Receiver Remote connector (RCE) for the duration of the mute.

3.2.2.1.13 Receiver Average Audio Output

3.2.2.1.13.1 VDL Mode 3

Not Applicable.

3.2.2.1.13.2 DSB-AM

a) After adjusting the MDR receiver Audio Output Level setting (Control Parameter ID#10) to produce an –8 dBm audio output from an RF input of –87 dbm 30 percent modulated with a 400 Hz tone, the MDR receiver **shall**$_{(680)}$ generate, with no further audio level adjustment, at the Main Audio Output:
   1) an average audio output of –13 dBm (±2 dB) averaged over 3 seconds, and

2) a peak audio output that does not exceed 0 dBm from an RF input of –87 dBm 90 percent modulated with a contractor-developed speech sample that is approved by the FAA.

b) Reserved

c) Reserved

3.2.2.1.14 Receiver Audio Distortion

3.2.2.1.14.1 VDL Mode 3

Not Applicable.

3.2.2.1.14.2 DSB-AM

a) The total distortion in the main and local audio output **shall**$_{(59)}$ not be more than 2.0 percent for 30 percent modulation or more than 5.0 percent for 90 percent modulation with any RF input level between -67 dBm and -27 dBm, for input tones varying between 300 Hz and 3.0 kHz.

3.2.2.1.15 Receiver Audio Frequency Response

3.2.2.1.15.1 VDL Mode 3

Not Applicable.

3.2.2.1.15.2 DSB-AM

a) With an RF input signal between -102 dBm and -7 dBm modulated 90 percent, the maximum variation in the main and local audio output **shall**$_{(60)}$ not be more than ±2.0 dB from the level achieved with a 1004 Hz input reference, when the input is varied between 300 Hz and 3.0 kHz.

b) The main and local audio output **shall**$_{(61)}$ decrease as the frequency increases between 3 kHz and 10 kHz.

c) The main and local audio output **shall**$_{(62)}$ be at least 20.0 dB down at 10.0 kHz and above.

d) Below 300 Hz, the main and local audio output **shall**$_{(63)}$ decrease as the frequency decreases and be down at least 10.0 dB at 100 Hz.

3.2.2.1.16 Receiver Squelch

3.2.2.1.16.1 Squelch

3.2.2.1.16.1.1 VDL Mode 3

a) The MDR receiver **shall**$_{(575)}$ search for appropriate burst synchronization as indicated by the information contained within the Sync Search Control message as per NAS-IC-41033502.

3.2.2.1.16.1.2 DSB-AM

a) The MDR receiver **shall**$_{(64)}$ have a squelch system consisting of both an RF level threshold and an audio signal-to-noise threshold.
b) Reserved
c) Main and local audio level spikes due to squelch **shall**$_{(66)}$ be 20.0 dB below the audio alignment level under any operating conditions. (The alignment level may be between -25 dBm to +20 dBm; in general, it is –8 dBm.)

3.2.2.1.16.2 Receiver Squelch Adjustment, Sensitivity, and Hysteresis

3.2.2.1.16.2.1 VDL Mode 3

Not Applicable.

3.2.2.1.16.2.2 DSB-AM

a) The squelch adjustment **shall**$_{(67)}$ provide the means to control squelch sensitivity locally using the MDT and/or remotely via RIU.
b) The MDR receiver main and local audio **shall**$_{(68)}$ be enabled when both an audio Signal-to-Noise ratio and RF power level exceed threshold values defined in c) and d) below.
c) The audio Signal-to-Noise threshold value **shall**$_{(69)}$ be adjustable (± 2 dB) anywhere in the range of +5 dB (minimum) to +15 dB.
d) The RF CW power level threshold value **shall**$_{(70)}$ be adjustable (± 2 dB) from –102 dBm to –50 dBm.
e) Squelch closing hysteresis on the RF power level **shall**$_{(72)}$ be not less than 2 dB and not greater than 5 dB with respect to the RF CW threshold level to which the MDR receiver is adjusted.

3.2.2.1.16.3 Receiver Squelch Attack and Release Times

3.2.2.1.16.3.1 VDL Mode 3

Not Applicable.

3.2.2.1.16.3.2 DSB-AM

a) With any RF input signal level between -97 dBm and -7 dBm, AM modulated 30 percent with a 1004 Hz tone, the squelch attack time **shall**$_{(73)}$ not exceed 10 ms.
b) The release time **shall**$_{(74)}$ not exceed 35 ms.

3.2.2.1.17 Collocation

3.2.2.1.17.1 VDL Mode 3

a) While in a fixed tuned configuration, the VDL Mode 3 sensitivity requirements defined in Section 3.2.2.1.3 **shall**$_{(75)}$ not be degraded by more than 8 dB (-92 dBm) in the presence of an off channel

transmitter, keyed, with a 15 watt carrier, DSB-AM modulated 90 percent with a 400 Hz tone or a 15 watt VDL Mode 3 transmitter with four slots active and in time synchronization with the desired signal, when the frequency separation and transmit-receive path isolation in Case A or Case B below is provided.

b) While in a remotely tunable configuration, the VDL Mode 3 sensitivity requirements defined in Section 3.2.2.1.3 **shall**$_{(387)}$ not be degraded by more than 14 dB (-86 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt carrier, DSB-AM modulated 90 percent with a 400 Hz tone or a 15 watt VDL Mode 3 transmitter with four slots active and in time synchronization with the desired signal, when the frequency separation and transmit-receive path isolation in Case A below is provided.

c) While in a remotely tunable configuration, the VDL Mode 3 sensitivity requirements defined in Section 3.2.2.1.3 **shall**$_{(388)}$ not be degraded by more than 28 dB (-72 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt carrier, DSB-AM modulated 90 percent with a 400 Hz tone or a 15 watt VDL Mode 3 transmitter with four slots active and in time synchronization with the desired signal, when the frequency separation and transmit-receive path isolation in Case B below is provided.

Case A

(1) VHF Path isolation of 42 dB (80 feet/24 meters) between receive and transmit antennas

(2) Transmit/Receive frequency separation of 0.5 MHz or greater

Case B

(1) VHF Path isolation of 28 dB (8 feet/2.4 meters) between receive and transmit antennas

(2) Transmit/Receive frequency separation of 2.0 MHz or greater

Note: For a definition of fixed tuned configuration and remotely tunable configuration see Section 6.2.12.

3.2.2.1.17.2 DSB-AM

a) While in a fixed tuned configuration, the DSB-AM sensitivity requirements defined in Section 3.2.2.1.3 **shall**$_{(77)}$ not be degraded by more than 10 dB (-92 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt carrier, DSB-AM modulated 90 percent with a 400 Hz tone or in the presence of a 15 watt VDL Mode 3 transmitter with four slots active, when the frequency separation and transmit-receive path isolation in Case A or Case B below is provided.

b) While in a remotely tunable configuration, the DSB-AM sensitivity requirements defined in Section 3.2.2.1.3 **shall**$_{(389)}$ not be degraded by more than 16 dB (-86 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt carrier, DSB-AM modulated 90 percent with a 400 Hz tone or in the presence of a 15 watt VDL Mode 3 transmitter with four slots active, when the frequency separation and transmit-receive path isolation in Case A below is provided.

c) While in a remotely tunable configuration, the DSB-AM sensitivity requirements defined in Section 3.2.2.1.3 **shall**$_{(390)}$ not be degraded by more than 30 dB (-72 dBm) in the presence of an off channel transmitter, keyed, with a 15 watt carrier, DSB-AM modulated 90 percent with a 400 Hz tone or in the presence of a 15 watt VDL Mode 3 transmitter with four slots active, when the frequency separation and transmit-receive path isolation in Case B below is provided.

Case A

(1) VHF Isolation of 42 dB (80 feet/24 meters) between receive and transmit antennas

(2) Transmit/Receive frequency separation of 0.5 MHz or greater

Case B

(1) VHF Isolation of 28 dB (8 feet/2.4 meters) between receive and transmit antennas

(2) Transmit/Receive frequency separation of 2.0 MHz or greater

3.2.2.1.18 Receiver Adjacent Channel Rejection

3.2.2.1.18.1 VDL Mode 3

a) The uncorrected BER requirement as defined in Section 3.2.2.1.2 **shall**$_{(79)}$ be achieved in the presence of a -55 dBm adjacent channel (centered on ± 25 kHz) interfering VDL Mode 3 signal in addition to a -97 dBm desired signal applied to the MDR RF input.

3.2.2.1.18.2 DSB-AM

a) The AM sensitivity requirement as defined in Section 3.2.2.1.3 **shall**$_{(80)}$ not be degraded by more than 3 dB in the presence of a -65 dBm adjacent channel (centered on ± 25 kHz) interfering AM signal, modulated 90 percent with a 400 Hz tone.

3.2.2.1.19 Receiver Rejection of Signals Outside the VHF Band

VDL Mode 3 and DSB-AM

a) The BER requirement for a VDL Mode 3 receiver while in a fixed tuned mode **shall**$_{(81)}$ be achieved when any of the below specified unwanted signals is applied in addition to the wanted signal set at an RF signal level of -98 dBm at the MDR RF input.

b) The DSB-AM sensitivity (see Section 3.2.2.1.3.2) while in a fixed tuned mode **shall**$_{(82)}$ not be degraded to a value worse than 10 dB SINAD when any of the below specified unwanted signals is applied in addition to the wanted signal set at an RF signal level of -100 dBm at the MDR RF input.

Unwanted Signal:	
Level :	- 4 dBm
Modulation :	None
Frequency range :	50 kHz – 1215 MHz (excluding the range 111.500 –

137.500 MHz)

3.2.2.1.20 Reserved

3.2.2.1.21 Receiver Desired Signal Dynamic Range

3.2.2.1.21.1 VDL Mode 3

a) The MDR receiver **shall**$_{(84)}$ achieve the uncorrected BER requirement (see Section 3.2.2.1.2) when operating with desired signal levels from –100 dBm up to -7 dBm at the MDR RF input.

3.2.2.1.21.2 DSB-AM

a) The MDR receiver **shall**$_{(85)}$ achieve a SINAD of 10 dB or greater when operating with desired signals modulated 90 percent with a 1004 Hz tone at an RF level from –102 dBm up to – 7 dBm at the MDR RF input.
b) The MDR receiver **shall**$_{(86)}$ not be blocked with desired signals modulated 90 percent with a 1004 Hz tone at the input levels up to +13 dBm.

Note: Blocking is defined as a 3 dB reduction in the audio level referenced to the audio level setting at the desired signal input of –7 dBm modulated 90 percent with a 1004 Hz tone.

3.2.2.1.22 Receiver Symbol Rate Capture Range

3.2.2.1.22.1 VDL Mode 3

a) The sensitivity requirement of Section 3.2.2.1.3 **shall**$_{(87)}$ be achieved when a desired signal is applied to the MDR RF input, with a symbol rate offset of ± seven (7) ppm (5 ppm airborne tolerance plus 2 ppm Doppler shift) from the nominal symbol rate of 10,500 symbols per second (see Section 3.2.1.2.1).

3.2.2.1.22.2 DSB-AM

Not Applicable.

3.2.2.1.23 Receiver Frequency Capture Range

3.2.2.1.23.1 VDL Mode 3

a) The MDR receiver **shall**$_{(88)}$ support synchronization acquisition and meet the sensitivity requirement of Section 3.2.2.1.3 with a maximum carrier frequency offset of ± 885 Hz plus receiver frequency stability from nominal for air/ground communications.

Note: This value takes into account the transmitter frequency error (685 Hz) from an airborne transmitter, and the air to ground transmission Doppler shift (200 Hz).

3.2.2.1.23.2 DSB-AM

a) The MDR receiver **shall**$_{(369)}$ meet the sensitivity requirement of Section 3.2.2.1.3 with a maximum carrier frequency offset of ± 885 Hz from nominal for air/ground communications.

Note: This value takes into account the transmitter frequency error (685 Hz) from an airborne transmitter, and the air to ground transmission Doppler shift (200 Hz).

3.2.2.1.24 Receiver Doppler Rate

3.2.2.1.24.1 VDL Mode 3

a) The sensitivity requirement of Section 3.2.2.1.3 **shall**$_{(89)}$ be met with a carrier frequency change rate of 18 Hz/s within the entire range of Doppler shift ± 200 Hz, and meeting the requirement of Section 3.2.2.1.23.1.

3.2.2.1.24.2 DSB-AM

a) The MDR receiver **shall**$_{(370)}$ meet the sensitivity requirement of Section 3.2.2.1.3 with a carrier frequency change rate of 18 Hz/s within the entire range of Doppler shift ± 200 Hz .

3.2.2.1.25 Receiver Co-Channel Interference

3.2.2.1.25.1 VDL Mode 3

a) The uncorrected BER requirement under a co-channel interference condition **shall**$_{(90)}$ be achieved when a ratio of wanted to unwanted signal of at most 20 dB is applied at the MDR RF input. The co-channel interference protection will be measured using a VDL Mode 3 signal at a desired signal level of -90 dBm and –50 dBm and –30 dBm.

Note: The interfering signal will be a continuous D8PSK waveform modulated with a pseudo-random sequence. The symbol rate clocks of the desired and the interfering signal will differ by at least 1 ppm. The pseudo-random sequences used for the desired and undesired signal will be of different lengths and the ratio of the lengths will not be an integer. The difference of 1 ppm in symbol rate clocks between the desired and interfering signals will guard against continual bit alignment between desired and undesired signals that could lead to non-repeatable BER measurements.

3.2.2.1.25.2 DSB-AM

Not Applicable.

3.2.2.1.26 Receiver Automatic Gain Control (AGC) Stabilization

3.2.2.1.26.1 VDL Mode 3

Not Applicable.

3.2.2.1.26.2 DSB-AM

a) The MDR receiver **shall**$_{(92)}$ produce a 10 dB SINAD with the minimum signal specified (see Section 3.2.2.1.17.2, Case B) not later than 20 milliseconds after insertion of a +14 dBm CW signal ±2 MHz away from the frequency to which the MDR receiver is tuned.
b) The MDR receiver **shall**$_{(93)}$ produce a 10 dB SINAD with the minimum signal specified (see Section 3.2.2.1.3) not later than 150 milliseconds after removal of a +14 dBm CW signal ±2 MHz away from the frequency to which the MDR receiver is tuned.

3.2.2.1.27 Receiver Internal Noise Level

3.2.2.1.27.1 VDL Mode 3

Not Applicable.

3.2.2.1.27.2 DSB-AM

a) For a –85 dBm RF input signal AM modulated at 30 percent with a 1004 Hz tone, the SINAD at the MDR receiver audio output **shall**$_{(94)}$ be at least 25 dB.

3.2.2.1.28 Receiver Power Measurement

3.2.2.1.28.1 VDL Mode 3

a) The accuracy of the MDR receiver power measurement reported to the RIU in the V-burst message, D-burst message and M-burst message **shall**$_{(631)}$ be ± 3dB over the input signal range specified in Section 3.2.2.1.21.1.
b) For V-burst messages and D-burst messages sent to the RIU, the Receive Power field **shall**$_{(632)}$ indicate the average receiver power measured over a minimum interval of 40 D8PSK symbol periods.
c) For M-burst messages sent to the RIU, the Receive Power field **shall**$_{(633)}$ indicate the average receiver power measured over a minimum interval of 16 D8PSK symbol periods.

3.2.2.1.28.2 DSB-AM

a) The accuracy of the MDR receiver power measurement reported to the RIU in the PCM voice message **shall**$_{(667)}$ be ± 3dB over the input signal range specified by the RF Input Power Level parameter in Table 3-4.
b) For PCM messages sent to the RIU, the Receiver Power field **shall**$_{(634)}$ indicate the average receiver power measured over the number of PCM samples reported in the PCM message (LEN/16).

3.2.2.2 MDR Transmitter Requirements

a) There **shall**$_{(95)}$ be two configurations of transmitters: 1) one configuration with an output power level adjustable from 2 watts to 15 watts, and 2) a configuration with an output power level adjustable from 10 watts to 50 watts.

Note: The two configurations may be delivered in a single enclosure (herein identified as a single enclosure).

b) b) For single enclosure designs, both the 15 watt and 50 watt requirements **shall**$_{(648)}$ be met unless otherwise specified.

3.2.2.2.1 Transmitter Digital and Audio Interfaces

a) There **shall**$_{(96)}$ be three audio inputs to the transmitter: 1) analog voice from the control site, 2) analog local voice from the jack on the front panel of the transmitter, and 3) PCM voice from the RIU.
b) The transmission of the voice input **shall**$_{(97)}$ be PTT controlled except for PCM voice, where the presence and absence of the voice packets implies a PTT.
c) Only one of the three audio inputs **shall**$_{(98)}$ be active at one time.
d) The MDR transmitter **shall**$_{(371)}$ receive a PTT signal for analog voice originating from the control site.

3.2.2.2.1.1 VDL Mode 3

a) Reserved
b) Voice **shall**$_{(101)}$ have priority over monitoring data. See Section 3.2.3.3.

3.2.2.2.1.2 DSB-AM

a) The MDR transmitter **shall**$_{(102)}$ have a main audio input at the rear of the transmitter. See Section 3.3.1.4.
b) The main audio input **shall**$_{(103)}$ have a balanced 600 ohm (± 10 percent) impedance.
c) There **shall**$_{(104)}$ be provisions for a local audio input from a push-to-talk microphone. See Section 3.3.1.6.
d) The microphone **shall**$_{(105)}$ plug directly into the front panel of the transmitter. See Section 3.3.1.6.

3.2.2.2.1.2.1 DSB-AM PCM Voice Transmission

a) The transmit MDR **shall**$_{(447)}$ perform DSB-AM modulation on the linear Pulse Code Modulation (PCM) sample stream provided by the RIU at a sampling rate of 8,000 16-bit PCM samples per second. The format of the PCM messages sent by the RIU is specified in NAS-IC-41033502.
b) At the start of a new uplink PCM voice transmission that requires more than one PCM message (EOM field = 0 in first PCM message), the transmit MDR **shall**$_{(448)}$ begin DSB-AM voice modulation between 0 and 9 milliseconds after the receipt of the second complete PCM message in the voice transmission from the RIU.

c) If the entire voice transmission requires less than two PCM messages (EOM field = 1 in first PCM message), the MDR **shall**$_{(449)}$ begin DSB-AM voice modulation no later than 9 milliseconds after the receipt of the PCM message HDLC end FLAG from the RIU.
d) After an uplink PCM DSB-AM uplink voice transmission has begun, the MDR **shall**$_{(450)}$ continuously modulate DSB-AM voice, while the HDLC end FLAG for each PCM message is received from the RIU at least 7.5 milliseconds prior to the time when the first PCM sample in the PCM message is required to be modulated.

3.2.2.2.2 Transmitter Time-Out

3.2.2.2.2.1 VDL Mode 3

The RIU will implement the time-out for VDL Mode 3.

3.2.2.2.2.2 DSB-AM

a) The transmitter **shall**$_{(106)}$ contain a time-out function for protection against, and the elimination of, extended periods of inadvertent continuous keying. See Table 3-3.
b) This adjustable transmitter time-out **shall**$_{(107)}$ range from 5 seconds up to 5 minutes in 5-second steps (limiting the maximum continuous keying of the transmitter to this time period).
c) The time-out feature **shall**$_{(108)}$ have provisions for disabling (see Section 3.2.3.2 and Table 3-3) to allow the transmitter unlimited continuous transmit operation.
d) Upon time-out, the MDR transmitter **shall**$_{(649)}$ cease radiating until the input PTT key is released and re-asserted.

3.2.2.2.3 Transmitter Distortion

3.2.2.2.3.1 VDL Mode 3

a) The error vector magnitude (EVM) of the D8PSK transmitted I/Q constellation **shall**$_{(109)}$ be not greater than 5 percent.

3.2.2.2.3.2 DSB-AM

a) With an audio tone input set to any frequency between 300 Hz and 3.0 kHz at any level between -25.0 dBm to +20.0 dBm, and the modulator adjusted to achieve 90 percent modulation, the resulting modulation distortion **shall**$_{(112)}$ not exceed 5 percent rms.
b) Over the same frequency range when the audio input level is set to achieve maximum limiting (see Section 3.2.2.2.4.2), the modulation distortion **shall**$_{(111)}$ not exceed 10 percent rms.

3.2.2.2.4 Transmitter AM Modulation Level

3.2.2.2.4.1 VDL Mode 3

Not Applicable.

3.2.2.2.4.2 DSB-AM

a) The MDR transmitter **shall**$_{(113)}$ prevent overmodulation of the carrier under all conditions and to retain a modulation level:
   1) at ± 10 percent of the setting of the Control Parameter ID#13, transmitter Modulation Percent (AM) and
   2) that does not exceed 100 percent for a 1004 Hz tone with an audio level that varies over the full specified input range when either the analog input (regardless of audio input level setting) or the PCM voice is used.

3.2.2.2.5 Transmitter RF Output Power

a) The MDR transmitter **shall**$_{(114)}$ operate in any mode at any power level for a load Voltage Standing Wave Ratio (VSWR) up to and including 3.0:1.
b) The MDR transmitter **shall**$_{(115)}$ not suffer any damage nor suffer subsequent performance degradation, and meets all its requirements after transmitting in any mode at any power level into a complex impedance of any magnitude and phase, including open and short circuit terminations.
c) The MDR transmitter **shall**$_{(116)}$ operate at a VSWR of 2.0:1 or less with no damage, with no part exceeding dissipation limits and with no performance degradation.
d) The MDR transmitter **shall**$_{(678)}$ meet the output power levels specified in either the remotely tuned configuration or the fixed tuned configuration.

3.2.2.2.5.1 VDL Mode 3

a) <u>VDL Mode 3, 15 Watt Configuration Power Output</u>
   1) The MDR transmitter **shall**$_{(117)}$ deliver the RF output (averaged over a V/D-burst or M-burst) as specified in the header of the burst into a nominal 50-ohm load impedance. For example, if for a burst a power of 42 dBm (15 watts) is specified in the header, the transmitter must generate a 42 dBm RF output as specified above.
   2) The MDR transmitter RF output **shall**$_{(118)}$ be adjustable in 0.5 dB steps over the range from 2 watts to 15 watts.
   3) The MDR transmitter **shall**$_{(119)}$ deliver not less than 50 percent of the set RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.
b) <u>VDL Mode 3, 50 Watts Configuration Power Output</u>
   1) The MDR transmitter **shall**$_{(120)}$ deliver the RF output (averaged over a V/D-burst or M-burst) as specified in the header of the burst into a nominal 50-ohm load impedance. For example, if for a burst a power of 47 dBm is specified in the header, the transmitter must generate a 47 dBm RF output as specified above.
   2) The MDR transmitter RF output **shall**$_{(121)}$ be adjustable in 0.5 dB steps over the range from 10 watts to 50 watts.
   3) The MDR transmitter **shall**$_{(122)}$ deliver not less than 50 percent of the set RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.
c) <u>VDL Mode 3, Single Enclosure Configuration Power Output</u>

1) The MDR transmitter **shall**$_{(687)}$ deliver the RF output (averaged over a V/D-burst or M-burst) as specified in the header of the burst into a nominal 50 ohm load impedance.
2) The MDR transmitter RF output **shall**$_{(688)}$ be adjustable in 0.5 dB steps over the range from 2 watts to 50 watts.
3) The MDR transmitter **shall**$_{(689)}$ deliver not less than 50 percent of the set RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.

3.2.2.2.5.2 DSB-AM

a) DSB-AM, 15 Watt Configuration Power Output
   1) The MDR transmitter **shall**$_{(124)}$ deliver the RF output specified in Control Parameter #12, Power Output, into a nominal 50 ohm load impedance when transmitting a CW signal. For example, if the control parameter specifies a power output setting of 42 dBm, the transmitter must generate 42 dBm RF output as specified above.
   2) The MDR transmitter **shall**$_{(125)}$ be adjustable in 0.5 dB steps over the range from 2 watts to 15 watts.
   3) The MDR transmitter **shall**$_{(126)}$ deliver not less than 50 percent of the set CW RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.

b) DSB-AM, 50 Watt Configuration Power Output
   1) The MDR transmitter **shall**$_{(128)}$ deliver the RF output specified in Control Parameter #12, Power Output, into a nominal 50 ohm load impedance when transmitting a CW signal. For example, if the control parameter specifies a power output setting of 47 dBm, the transmitter must generate 47 dBm RF output as specified above.
   2) The MDR transmitter **shall**$_{(129)}$ be adjustable in nominal 0.5 dB steps over the range from 10 watts to 50 watts maximum unmodulated CW RF power.
   3) The MDR transmitter **shall**$_{(130)}$ deliver not less than 50 percent of the set CW RF signal power into any impedance having a maximum VSWR of 3:1 at any phase angle.

c) DSB-AM, Single Enclosure Configuration Power Output
   1) The MDR transmitter **shall**$_{(690)}$ deliver the RF output as specified in the Control Parameter #12. Power Output, into a nominal 50 ohm load impedance when transmitting a CW signal.
   2) The MDR transmitter **shall**$_{(691)}$ be adjustable in nominal 0.5 dB steps oer the range from 2 watts to 50 watts maximum unmodulated CW RF power.
   3) The MDR transmitter **shall**$_{(692)}$ deliver not less than 50 percent of the set CW RF signal power inot any impedance having a maximum VSWR of 3:1 at any phase angle.

3.2.2.2.5.3 TDMA Slot Power Setting Requirements

a) The MDR transmitter **shall**$_{(131)}$ have the ability to change the power in each TDMA slot for VDL Mode 3 operation.

Note: The power is assignable over the range of the power specified in this specification. An example of this requirement for a 15 watt transmitter may be: Slot 1 – 2 watts, Slot 2 – 7 watts, Slot 3 – 15 watts, and Slot 4 – 4 watts.

3.2.2.2.5.4 Transmitter Leakage

VDL Mode 3 and DSB-AM

a) When unkeyed, the MDR transmitter **shall**$_{(134)}$ not produce more than -97 dBm in-band leakage measured at the MDR RF output.

3.2.2.2.6 Transmitter Back Intermodulation

VDL Mode 3 and DSB-AM

a) In the fixed tuned configuration, the amplitude of each radio frequency back intermodulation product **shall**$_{(135)}$ be at least 40 dB below the amplitude of an interfering signal fed into the MDR RF output at either:
   1) 28 dB below the transmitter maximum output level and spaced ± 2 MHz from the MDR transmitter output frequency or
   2) 42 dB below the transmitter maximum output level and spaced ± 500 kHz from the MDR transmitter output frequency.

3.2.2.2.7 Transmitter Duty Cycle

3.2.2.2.7.1 VDL Mode 3

a) The MDR transmitter **shall**$_{(136)}$ operate at a 79.5 percent duty cycle at the maximum rated output continuously, for at least 8,760 hours.

3.2.2.2.7.2 DSB-AM

a) The MDR transmitter **shall**$_{(137)}$ operate at a 100 percent duty cycle at the maximum rated output continuously for at least 8,760 hours.

3.2.2.2.8 Transmitter Spurious Emissions

VDL Mode 3 and DSB-AM

a) Spurious emission levels **shall**$_{(138)}$ meet the limits imposed by the transmit mask of Section 3.2.2.2.10.

Note: Spurious emissions exclude the harmonics specified in Section 3.2.2.2.9.

3.2.2.2.9 Transmitter Harmonic Output

VDL Mode 3 and DSB-AM

a) The level of each harmonic frequency of the carrier **shall**$_{(139)}$ be less than -80.0 dBc (-65 dBm within the Global Navigation Satellite System (GNSS) band) when measured at the MDR RF output. This measurement will be at 15 watts and 50 watts, respectively, for the 15 watt and 50 watt configurations (VDL Mode 3 and DSB-AM modes).

Note: In order to provide adequate protection of a GNSS receiver when a VDL transmitter is operated, special care should be taken by the manufacturer to ensure that the transmitter harmonic filter remains effective at frequencies in the band 800 to 1800 MHz. In order for a single enclosure MDR transmitter to satisfy both the 15 watt and 50 watt configurations, all conditions must be met (i.e., testing at 15 watts and 50 watts in VDL Mode 3 and DSB-AM modes).

3.2.2.2.10 Transmitter Adjacent Channel Power

a) 15 Watt and 50 Watt Configurations, Fixed-Tuned Configuration, VDL Mode 3 and DSB-AM Modulated 90 Percent with a 1004 Hz Tone
   1) While in a fixed tuned configuration, the amount of power from an MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel **shall**$_{(140)}$ not exceed -40 dBc (-62 dBc in center 16 kHz).
   2) The amount of power from an MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second and third adjacent channels **shall**$_{(141)}$ be -65 dBc maximum, -70 dBc maximum for the fourth through seventh adjacent channels, -75 dBc maximum for the eighth through fifteenth adjacent channels, -92 dBc maximum for the sixteenth through nineteenth adjacent channels, and -113 dBc maximum for any frequency greater than 500 kHz from the tuned channel center and -137 dBc maximum for any frequency greater than 2 MHz from the tuned channel center. (See Figure 3-1 below.)

b) 15 Watt and 50 Watt Configurations, Remotely Tunable Configuration, VDL Mode 3 and DSB-AM Modulated 90 Percent with a 1004 Hz tone)
   1) While in a remotely tunable configuration, the amount of power from an MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel **shall**$_{(391)}$ not exceed -40 dBc (-62 dBc in center 16 kHz).
   2) The amount of power from an MDR transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second and third adjacent channels **shall**$_{(392)}$ be -65 dBc maximum, -70 dBc maximum for the fourth through seventh adjacent channels, -75 dBc maximum for the eighth through fifteenth adjacent channels, -92 dBc maximum for the sixteenth through nineteenth adjacent channels, and -107 dBc maximum for any frequency greater than 500 kHz from the tuned channel center. (See Figure 3-1 below.)

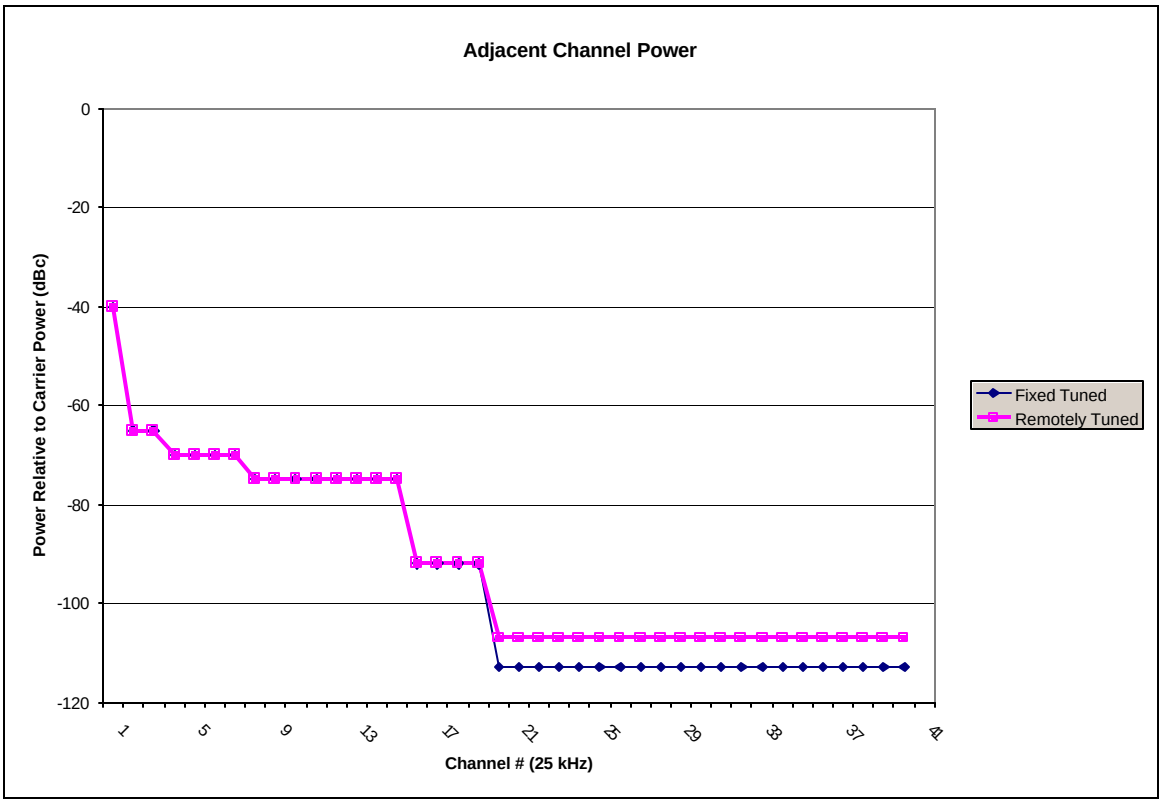


Figure 3-1: Adjacent Channel Power

3.2.2.2.11 Transmitter Carrier-Induced Noise (Residual AM)

3.2.2.2.11.1 VDL Mode 3

Not Applicable.

3.2.2.2.11.2 DSB-AM

a) The carrier-induced audio noise level due to the MDR transmitting a CW signal **shall**$_{(142)}$ be at least 40.0 dB below the detected audio output (300 Hz – 3.0 kHz detected bandwidth) when the carrier is modulated 90 percent with a 1004 Hz tone.

b) The MDR transmitter **shall**$_{(706)}$ provide a Transmit Confirmation via the Transmitter remote connector for as long as the MDR is keyed in AM mode

3.2.2.2.12 Transmitter Keying

a) The MDR transmitter **shall**$_{(697)}$ provide a Transmit Indicator signal via the Transmitter remote connector (RCE) for the duration of the transmissions.

b) The MDR transmitter **shall**$_{(704)}$ provide a Transmit Confirmation via the Transmitter remote connector for as long as the MDR is keyed in AM mode.

3.2.2.2.12.1 VDL Mode 3

a) The MDR transmitter **shall**$_{(698)}$ output the Transmit Indicator signal within ±10 microseconds of the leading edge of the first D8PSK symbol of the RF ramp-up and disable the signal ±10 microseconds of the falling edge of the last D8PSK symbol of the RF ramp-down.
Note: The MDR transmitter keying will be controlled by the RIU.

3.2.2.2.12.2 DSB-AM

a) The MDR transmitter **shall**$_{(143)}$ accept both local and remote keying signals.
b) The local keying signal **shall**$_{(144)}$ be via a push-to-talk microphone connected directly to the transmitter front panel microphone jack. See Section 3.3.1.6.
c) Remote keying signals **shall**$_{(145)}$ be via the application of a ground, or alternately, +6 VDC to +48 VDC. See Section 3.3.1.4.
d) The remote keying signals for current or voltage control **shall**$_{(146)}$ be on separate pins of the MDR transmitter remote connector.
e) Remote keying signals **shall**$_{(147)}$ take priority over local keying signals when the MDR transmitter is on-line.
f) For ground keying, the source current required **shall**$_{(148)}$ not exceed 10 milliamperes and not generate a pull-up voltage exceeding 40 volts.
g) The keying time **shall**$_{(149)}$ not exceed 15 milliseconds as measured from the application of a keying signal to the time when the MDR transmitter is at 90 percent of the full power level.
h) The MDR transmitter **shall**$_{(150)}$ continue to transmit while the keying signal is present per item 3.2.2.2.12.2c above , except as specified in 3.2.2.2.2.
i) The sink current **shall**$_{(151)}$ not exceed 0.5 mA with voltage keying.
j) An open keyline **shall**$_{(373)}$ be interpreted as non-keyed.

3.2.2.2.13 Transmitter Frequency Tolerance

VDL Mode 3 and DSB-AM

a) The MDR transmitter frequency tolerance **shall**$_{(152)}$ be within ± 0.0001 percent (±1.0 ppm) of the Current Frequency (See Table 3-3, ID#2) for any period of one year following alignment over the full frequency range specified in Section 3.2.1.1.1, and the temperature range specified in Section 3.4.3.1.
b) The reference used to derive the transmitter operating frequency **shall**$_{(393)}$ have a tuning adjustment adequate to compensate for aging during the operational life of the equipment.
c) The transmitter operating frequency **shall**$_{(395)}$ be adjustable within ± 1 ppm of the tuned channel center frequency.

3.2.2.2.14 Antenna Transfer Relay (ATR) Operation

a) The MDR transmitter **shall**$_{(374)}$ include an ATR function, supported in both DSB-AM and VDL Mode 3 modes, which connects a single shared antenna to the host MDR transmitter (i.e., the MDR transmitter with both the ATR function and the direct connection to the antenna) and another MDR.

Note: Envisioned configurations of multiple MDRs are described in Section 6.3. The concept of the ATR function is illustrated in Figure 6-1, Section 6.2.12.

b) The ATR **shall**$_{(375)}$ support the following antenna configurations:
   1) Transmitter/Receiver on the same frequency for transceiver (T/R) operation (see example in Figure 6-3);
   2) Transmitter/Transmitter on the same frequency for main/standby (TX M/S) operation (see example in Figure 6-4);

c) The ATR **shall**$_{(693)}$ operate on one of two modes:
   1) Static Mode, where the switch state is controlled by an explicit command from the RIU or MDT: and
   2) Dynamic Mode, where the switch state is controlled be the local MDR's need to transmit.

d) In the Dynamic Mode, when the antenna is in use by the local MDR (actively transmitting), the ATRC (common) connector **shall**$_{(376)}$ be routed to the ATR2 connector.

e) In the Dynamic Mode, when the antenna is not in use by the local MDR, the ATRC (common) connector **shall**$_{(377)}$ be routed to the ATR1 connector.

f) Failure of the local MDR **shall**$_{(379)}$ not prevent or degrade the ATRC to ATR1 path (e.g., the failed or default Path is ATRC to ATR1).

g) In the T/R configuration, the ATR **shall**$_{(380)}$ switch fast enough for interslot and intraslot VDL Mode 3 operation. *(This includes receiving an M-burst from a maximum range aircraft and then having to transmit a V/D-burst.)* The MDR is not required to support interslot operation in the M/S configuration.

h) In the T/R configuration, the ATR **shall**$_{(381)}$ provide sufficient isolation between the ATR1 and ATR2 connector paths during MDR transmissions (ATRC to ATR2) to prevent signals stronger than –7 dBm from reaching the MDR receiver (ATR1).

i) In the T/R configuration, the ATR **shall**$_{(382)}$ provide sufficient leakage from the MDR transmitter (ATR2) to the MDR receiver (ATR1) to allow the MDR receiver(s) to monitor if the MDR transmitter is operating, without damaging the MDR receiver(s).

j) In the TX M/S configuration, the ATR **shall**$_{(383)}$ provide sufficient isolation between the ATR1 and ATR2 connector paths to prevent damage to the non-radiating transmitter.

k) In the Static Mode, the ATR **shall**$_{(620)}$ provide connectivity between the ATRC and ATR1 or ATR2 based on the ATR Switch State (ID-14) (e.g. ATR1 (Remote) for Standby Transmitter operation and ATR2 (Local) for Main Transmitter operation).

l) The ATR operation **shall**$_{(384)}$ allow for the use of the internal filter and/or an external RF filter in any configuration (see Figures 6-3 and 6-4).

m) The MDR **shall**$_{(385)}$ be equipped with three external, removable jumpers capable of operational use to provide connectivity between: 1) the MDR RF and ATR2 connectors, 2) the MDR RF to FILTER IN connectors, and 3) the FILTER OUT to ATR2 connectors.
n) The ATR **shall**$_{(621)}$ have a maximum allowable loss of 1dB. This loss is considered additional degradation beyond the required power output and receiver sensitivity.
o) The ATR Switch **shall**$_{(677)}$ not degrade:
   1) Performance of the transmitter connected directly to the antenna;
   2) Performance of the transmitter connected to the antenna through its ATR switch;
   3) Performance of a second transmitter connected to the antenna through the ATR switch;
   4) Performance of the receiver connected to the antenna through the ATR switch, except as specified in Section 3.2.2.2.14n.

3.2.3 Site Control and Monitoring

a) Reserved
b) The MDR **shall**$_{(576)}$ allow local control and monitoring by interface and interoperation with the Maintenance Data Terminal (MDT), as specified in the MDT Maintenance Application Software Requirements Specification (SRS), FAA-E-2944.

3.2.3.1 MDR Control

a) The MDR control functions **shall**$_{(157)}$ support real-time system management actions from the following two control points when the MDR is in the Online and Offline state , and when the MDR is in Recovery or Failed states in accordance with the state definitions in Section 6.2.15:
   1) Maintenance Data Terminal (MDT) connector located on the front of the MDR receiver and transmitter provides local control (See Section 3.3.2.1.)
   2) RIU data connector located on the rear of the MDR receiver and transmitter provides remote control. (See Section 3.3.2.2.)

3.2.3.1.1 Maintenance Data Terminal (MDT) Interface

The MDT SRS, FAA-E-2944, contains a description of the MDT functionality. The following requirements, which support the MDT operation, apply to the MDR receiver and transmitter:
a) The MDR **shall**$_{(158)}$ accept control input, provide control replies, and provide monitoring output and alarm/alert indications via the MDT connector.
b) The MDR **shall**$_{(160)}$ continue to operate with an MDT connected, logged in, and upon removal of the MDT.

3.2.3.1.2 Remote Maintenance Monitoring and Control

a) The MDR/RIU **shall**$_{(161)}$ accept control input from the RIU and provide control replies, monitoring output and alarm/alert indications to the RIU via the MDR/RIU connector.

3.2.3.2 Control Parameter Adjustments

a) The MDR **shall**$_{(163)}$ allow modification of the control parameters of the MDR receiver and transmitter summarized in Table 3-3.
b) Reserved
c) The MDR receiver and transmitter **shall**$_{(452)}$ set parameters to within the tolerance of the associated monitoring parameter (i.e., same Parameter ID).

Note: In some cases the step size is finer than the resolution to allow for finer tuning of the parameters using exterior test equipment.

Note: The control parameter value ranges, maximum step sizes and default values are summarized in Table 3-3.

d) The MDR **shall**$_{(579)}$ reply to Control request messages (RR=1 per NAS-IC-41033502) with a Control reply message (RR=0) containing the parameter setting actually enacted by the MDR.
e) Rejected Control request messages **shall**$_{(580)}$ contain the original parameter setting with an error code indicating the reason for rejection, per NAS-IC-41033502.
f) All control parameters in Table 3-3 **shall**$_{(581)}$ be modifiable when the MDR is in the Offline state.
g) When in the Online state, the MDR **shall**$_{(582)}$ reject all control parameter commands except the following:

1	Log In
5	MDR State
6	Alarm/Alert Threshold Setting
8	Squelch RF Threshold Level Setting
9	Squelch Audio Signal-to- Noise Threshold Level Setting
11	Receiver Mute
13	Transmitter Modulation
14	ATR Switch State
20	Transmission Timeout
21	Squelch Enable/Disable
30	Request Read Back
34	MAC Timing Offset Correction
35	Suppress Alarm/Alert
36	Reset
37	Software Upload Enable/Disable
38	Software Upload

Table 3-3: Receiver and Transmitter Control Parameters

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both
1	**Log-In/Log Out**: The Log-In/Log Out parameter allows the log-in through an MDT/RIU and allows the MDT/RIU initiated Log-Out.	Discrete values: Date/Time, User ID, User Terminal ID, Security Token	N/A	N/A	N/A	N/A	Both
2	**Current Frequency**: The Current Frequency parameter sets the desired current frequency of the MDR receiver and transmitter.	Multiple discrete frequency values	112.00000 MHz or Lowest Tunable Freq.	136.97500 MHz	8 1/3 kHz	118.00000 MHz	Both
3	**Lowest Tunable Frequency**: The Lowest Tunable frequency parameter sets the minimum frequency that the MDR can be tuned.	Multiple discrete frequency values	112.00000 MHz	118.00000 MHz	25 kHz	118.00000 MHz	Both
4	**Mode of Operation**: The Mode of Operation parameter sets whether MDR component is in the 25kHz DSB-AM, 8.33kHz DSB-AM, or VDL Mode 3.	Three values (representing the modes)	N/A	N/A	N/A	25 kHz DSB-AM	Both
5	**MDR State** : The MDR State parameter instructs the MDR component to alter its operational state (three discrete values: Power Down (if exercised), Offline, Online).	One of three discrete values (representing the controllable states)	N/A	N/A	N/A	Offline	Both
6	**Threshold Setting**: The Threshold Setting parameter provides new alert and alarm threshold values for the various monitoring parameters. This parameter includes the parameter ID and the new alert and alarm thresholds.	Parameter values (see Table 3-4) Anywhere in range of parameter	-	-	-	See Table 3-4	Both
7	**Time:** The Time parameter sets the time of the clock in the MDR receiver and MDR transmitters used for time stamping log entries.	Time in the format MM/DD/YYYY HH:MM:SS.SS	N/A	N/A	N/A	01/01/2000 00:00:00.00	Both
8	**Squelch RF Threshold Level Setting (AM)**: The receiver Squelch RF Threshold Level Setting parameter sets the RF power squelch thresholds for the DSB-AM modes.	Discrete Settings	0	63	1	3	RX
9	**Squelch Audio Signal-to-Noise Threshold Level Setting (AM)**: The receiver Squelch Audio Signal-to-Noise Level Setting parameter sets the audio signal-to-noise thresholds for the DSB-AM modes.	Discrete Settings	0	10	1	3	RX
10	**Audio Output Level (AM)**: The Audio Output Level parameter sets the desired audio output level on the main audio output of the MDR receiver.	Power in dBm	-25 dBm	20 dBm	0.5 dB	-8 dBm	RX
11	**Receiver Mute (AM)**: The Receiver Mute parameter mutes or unmutes the MDR receiver for DSB-AM.	Two values: Muted, Unmuted	N/A	N/A	N/A	Unmuted	RX

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both
12	**Power Output (AM)**: The Power Output parameter sets the MDR Transmitter RF output power (CW). (Top row applies to 15W transmitter configuration, middle row applies to 50W transmitter configuration, and bottom row applies if a single transmitter enclosure is used for both 15 and 50 W)	Power values in dBm	33 dBm	42 dBm	0.5 dB	33 dBm	TX
			40 dBm	47 dBm	0.5 dB	40 dBm	
			33 dBm	47 dBm	0.5 dB	33 dBm	
13	**Transmitter Modulation % (AM)**: The Transmitter Modulation % parameter sets the MDR Transmitter modulation percentage for DSB-AM modes.	Percent	0%	100%	100 steps	90%	TX
14	**ATR Switch State:** The ATR Switch State parameter controls the ATR switch connection to the antenna when in Static Mode. (The 2 discrete values are: ATR1 and ATR2.)	Two Discrete values: ATR1, ATR2	N/A	N/A	N/A	ATR2	TX
15	**Switch Software Version:** This is an action signal that indicates to the equipment to reboot with the stored software image indicated.	One Value: Switch SW Version	N/A	N/A	N/A	N/A	Both
16	**N1 (Number of Information Bits):** This parameter sets the maximum number of bits in the information fields.	Number of Bits	128	4096	8	512	Both
17	**T1 (Link Response Timer):** This parameter sets the link response timer.	ms	100	500	1	200	Both
18	**T3 (Reassembly Timer):** This parameter sets the reassembly timer.	ms	50	65,535	1	250	Both
19	**HDLC Channel Number**: HDLC channel to use for MDR per NAS-IC-41033502	Five Discrete numbers	1	5	1	1	Both
20	**Transmission Timeout (AM)**: The Transmission Timeout parameter sets the time-out value or disables the timer. Setting the value for a disabled timer will re-enable the timer.	Seconds	0 sec (Disabled)	300 sec	5 sec	35 sec	TX
21	**Squelch Enable/Disable (AM)**: This command activates or deactivates the squelch feature of the MDR.	Two Discrete: ENABLE, DISABLE	N/A	N/A	N/A	ENABLE	RX
22	**ATR Switch Mode:** The ATR Switch Mode parameter that controls the mode of operation for the ATR switch.	Two Discrete values: Static, Dynamic	N/A	N/A	N/A	Static	TX
30	**Request Read Back**: The Read Back Request parameter informs the MDR component to send the applicable information for the desired monitoring parameter	Five fields: Monitoring Parameter ID, Iterations, Interval, Filter and Data	N/A	N/A	N/A	N/A	Both

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both
31	**Audio Input level (AM)**: The transmitter Audio Input Level parameter sets the audio input level expected at the main audio output of the MDR transmitter used to set the audio input gain.	Power in dBm	-25 dBm	+20 dBm	0.5 dB	-8 dBm	TX
32	RESERVED	-	-	-	-	-	-
33	RESERVED	-	-	-	-	-	-
34	**MAC Timing Offset Correction (VDL Mode 3)**: The VDL MAC Timing Offset Correction parameter indicates the relative time correction, in microseconds, that should be applied to all MDR M-burst and V/D-burst operations, relative to the previous perceived MAC 6-second epoch in the MDR, which is derived from the receive T1 framing and Timing Channel from the RIU.	Time in µs	-32768 µs	32767 µs	1 µs	0	Both
35	**Suppress Alert/Alarm:** The Suppress Alert/Alarm parameter is an action signal to command the MDR to cease transmitting alert and alarm messages to the MDT and RIU, or resume normal alert and alarming.	Two discrete values: Suppress, Normal	N/A	N/A	N/A	Normal	Both
36	**Reset**: This is an action signal that commands the MDR to do a warm boot reset (restart while retaining control parameter settings) or a factory reset (restart after returning all control parameters to initialization default values)	Two discrete values: Warm Reset, Factory Reset	N/A	N/A	N/A	N/A	Both
37	**Software Upload Enable/Disable**: This is an action signal that enables the equipment to upload operational software..	Two discrete values: Enable Upload, Disable Upload	N/A	N/A	N/A	Disable Upload	Both
38	**Software Upload**: This is the mechanism for actually uploading the operational software executable image. This parameter is used in conjunction with parameter 37.	Three Fields: Block Number, Total Blocks, Binary Data (variable length)	N/A	N/A	N/A	N/A	Both
39	**Receiver Mute Level (AM)**: This command sets the attenuation level of the receiver muting.	Three Discrete values: -15dB, -20dB, no audio	N/A	N/A	N/A	No audio	RX
40	**Test PTT (AM):** This command keys the transmitter for testing purposes.	Two Discrete values: TEST_KEYED, NOT_TEST_ KEYED	N/A	N/A	N/A	NOT_TEST_ KEYED	TX

ID	Parameter	Type	Min	Max	Step	Initialization Default	Applicability: TX, RX, Both
41	**Public Key Maintenance:** Allows the MDT/RIU to add or delete MDR-stored Public keys.	Date/Time, User, User Terminal, Add/Subtract Indicator, Key Number, Key ID, Security Token	N/A	N/A	N/A	N/A	Both
42	**T2 (Link Retransmission Timer):** This parameter sets the link retransmission timer used in link clearing.	Sec	1	10	1	5	Both

Notes:

1. *The default values for each parameter represents the "hard-coded" factory settings required upon MDR initialization.*
2. *Parameters 30, 36 and 38 do not have associated monitoring parameters.*
3. *The parameter ID corresponds to the CTYPE field as defined in NAS-41033502.*
4. *Values in the upper row of ID #12 are for the 15W max transmitter configuration, values in the middle row are for the 50 W max transmitter configuration, and values in the bottom row are applicable if a single transmitter enclosure is used to fulfill the requirements of both the 15W and the 50W transmitters.*

3.2.3.2.1 Log-In / Log-Out (ID = 1)

a) The log-in/log-out parameter **shall**$_{(454)}$:
   1) Allow the log-in through the MDT/RIU and allow the MDT/RIU initiated log-out as per Section 3.2.3.2g
   2) Include a date/time field, the user identifier, the user terminal identifier, and the security token
   3) Be applicable to MDR receivers and MDR transmitters
   4) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.2 Current Frequency (ID = 2)

a) The current frequency control parameter **shall**$_{(455)}$:
   1) Set the desired frequency of the MDR receiver or MDR transmitter as per Section 3.2.1.1.1
   2) Be a set of multiple discrete frequency values
   3) Have a minimum value of 112.00000 MHz
   4) Have a maximum value of 136.97500 MHz
   5) Have a step value of 8 1/3 kHz
   6) Have a default value of the last tuned frequency on Restore, 118.00000 MHz on Initialization
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a message/bit format that complies with the MDR/RIU ICD (NAS-IC-41033502)

3.2.3.2.3 Lowest Tunable Frequency (ID = 3)

a) The lowest tunable frequency parameter **shall**$_{(456)}$:

1) Set the lowest tunable frequency of the MDR receiver or MDR transmitter as per Section 3.2.1.1.1b.
2) Be a set of multiple discrete frequency values
3) Have a minimum value of 112.00000 MHz
4) Have a maximum value of 118.00000 MHz
5) Have a step value of 25 kHz
6) Have a default value of 118.00000 MHz
7) Be applicable to the MDR receiver and MDR transmitters
8) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.4 Mode of Operation (ID = 4)

a) The mode of operation parameter **shall**$_{(457)}$:
   1) Set the MDR receiver or MDR transmitter in the 25 kHz DSB-AM, 8 1/3 kHz DSB-AM, or VDL Mode 3 modes as per Section 3.2.1.1
   2) Be a set of three discrete values: 25kHz DSB-AM, 8 1/3 kHz DSB-AM, VDL Mode 3
   3) Have a default value of 25 kHz DSB-AM mode
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.5 MDR State (ID = 5)

a) The MDR state parameter **shall**$_{(458)}$:
   1) Instruct the MDR receiver or MDR transmitter to alter its operational state as per Section 3.2.1.5
   2) Be one of three discrete values representing the states (Power Down (if exercised), Online, Offline)
   3) Have a default value of Offline
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.6 Threshold Setting (ID = 6)

a) The threshold setting parameter **shall**$_{(459)}$:
   1) Provide new alert and alarm threshold values for the various monitoring parameters, including the parameter ID and the new alert and alarm thresholds as per Section 3.2.3.4
   2) Contain thresholds for low Alarm, high Alarm, low Alert, high Alert (as applicable) of variable type with values anywhere in the range of the associated parameter values specified in Table 3-4
   3) Have a default value (of the selected parameter) as specified in Table 3-4
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.7 Time (ID = 7)

a) The time parameter **shall**$_{(460)}$:
   1) Set the time of the clock in the MDR receiver or MDR transmitter used for time stamping log entries as per Section 3.2.3.6.
   2) Be in the time format of MM/DD/YYYY/HH:MM:SS.SS
   3) Have a default value of 01/01/2000/00:00:00.00
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.8 Squelch RF Threshold Level Setting (AM) (ID = 8)

a) The squelch RF threshold level setting (AM) parameter **shall**$_{(461)}$:
   1) Set the RF power squelch threshold for the DSB-AM modes as per Section 3.2.2.1.16
   2) Be a discrete setting
   3) Have a minimum value of 0
   4) Have a maximum value of 63
   5) Have a step value of 1
   6) Have a default value of 3
   7) Correlate settings of 0 to 63 to denote RF input power levels in the range of –102 dBm to –50 dBm, with setting of 0 correlating to RF input power level of –102 dBm, and setting of 63 correlating to RF input power level of –50 dBm
   8) Be applicable to the MDR receiver
   9) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.9 Squelch Audio Signal-to-Noise Level Setting (AM) (ID = 9)

a) The squelch audio signal-to-noise level setting parameter **shall**$_{(583)}$:
   1) Indicate the audio signal-to-noise ratio needed to break the DSB-AM squelch of the MDR receiver as per Section 3.2.2.1.16
   2) Be discrete values
   3) Have a minimum value of 0
   4) Have a maximum value of 10
   5) Have a resolution (step size) of 1
   6) Correlate settings of 0 to 10 to denote squelch audio signal-to-noise levels in the range of +5 dB to +15 dB, with setting of 0 correlating to squelch audio signal-to-noise ratio of +5 dB, and setting of 10 correlating to squelch audio signal-to-noise ratio of +15 dB
   7) Be applicable to the MDR receiver
   8) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.10 Audio Output Level (AM) (ID = 10)

a) The receiver audio output level (AM) parameter **shall**$_{(462)}$:
   1) Set the desired audio output level on the main audio output of the MDR receiver to support Section 3.2.2.1.9
   2) Be a power level in dBm

3) Have a minimum value of -25 dBm
4) Have a maximum value of 20 dBm
5) Have a step value of 0.5 dB
6) Have a default value of –8 dBm
7) Be applicable to the MDR receiver
8) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.11 Receiver Mute (AM) (ID = 11)

a) The receiver mute (AM) parameter **shall**$_{(463)}$:
   1) Mute or unmute the MDR receiver for the DSB-AM modes as per Section 3.2.2.1.12.2
   2) Be a set of two discrete values: Muted or Unmuted
   3) Have a default value of Unmuted
   4) Be applicable to the MDR receiver
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.12 Power Output (AM) (ID = 12)

a) The output power parameter **shall**$_{(464)}$:
   1) Set the MDR transmitter RF output power (CW) as per Section 3.2.2.2.5.2
   2) Be an RF power level in dBm
   3) Have a minimum value for the 15 watt MDR transmitter configuration of 33 dBm
   4) Have a minimum value for the 50 watt MDR transmitter configuration of 40 dBm
   5) Have a minimum value of 33 dBm if a single MDR transmitter enclosure is used for both 15 and 50W requirements.
   6) Have a maximum value for the 15 watt MDR transmitter configuration of 42 dBm
   7) Have a maximum value for the 50 watt MDR transmitter configuration of 47 dBm
   8) Have a maximum value of 47 dBm if a single MDR transmitter enclosure is used for both 15 and 50W requirements.
   9) Have a resolution (step size) of 0.5 dB for all transmitter configurations
   10) Reserved
   11) Have a default value for the 15 watt MDR transmitter configuration of 33 dBm
   12) Have a default value for the 50 watt MDR transmitter configuration of 40 dBm
   13) Have a default value of 33 dBm if a single MDR transmitter enclosure is used for both 15W and 50W requirements.
   14) Be applicable to the MDR transmitters
   15) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.13 Transmission Modulation % (AM) (ID = 13)

a) The transmission modulation % (AM) parameter **shall**$_{(465)}$:
   1) Set the MDR transmitter modulation percentage for the DSB-AM modes as per Section 3.2.2.2.4
   2) Be in percent of modulation

3) Have a minimum value of 0 percent
4) Have a maximum value of 100 percent
5) Have a step value of 1 percent
6) Have a default value of 90 percent
7) Be applicable to the MDR transmitters
8) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.14 ATR Switch State (ID = 14)

a) The ATR switch state parameter **shall**$_{(466)}$:
   1) Control the connection to the antenna for the ATR switch when in the Static mode
   2) Be two discrete values: ATR1 or ATR2
   3) Have a default value of: ATR2
   4) Be applicable to the MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.15 Switch Software Version (ID = 15)

a) The switch software version parameter **shall**$_{(467)}$:
   1) Indicate to the MDR receiver or the MDR transmitter to reboot to the alternate stored software image indicated in support of Section 3.2.1.4
   2) Cause the MDR to transition to the Power Up state and begin operation using the alternate software image (and initiate Power Up sequence) after two Switch Software Version control parameters are received within 1 second.
   3) Only be accepted when in the Offline state
   4) Be one value: Switch Software Version
   5) Be applicable to the MDR receiver and MDR transmitters
   6) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.16 N1 (Number of Information Bits) (ID = 16)

a) The N1 parameter **shall**$_{(468)}$:
   1) Set the maximum number of bits in the information fields as defined in Section 3.2.1.6.3a
   2) Be in Number of Bits
   3) Have a minimum value of 128 bits
   4) Have a maximum value of 4096 bits
   5) Have a step value of 8 bits
   6) Have a default value of 512

   Note: For PCM Voice operation, the N1 parameter will be set to 1976 to allow for larger frames to ease operation of the MDR.

   7) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.17 T1 (Link Response Timer) (ID = 17)

a) The T1 parameter **shall**$_{(469)}$:
   1) Set the link response timer as defined in Section 3.2.1.6.3b
   2) Be in milliseconds
   3) Have a minimum value of 100 milliseconds
   4) Have a maximum value of 500 milliseconds
   5) Have a step value of 1 millisecond
   6) Have a default value of 200 milliseconds
   7) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.18 T3 (Reassembly Timer) (ID = 18)

a) The T3 parameter **shall**$_{(470)}$:
   1) Set the reassembly timer as defined in Section 3.2.1.6.3d
   2) Be in milliseconds
   3) Have a minimum value of 50 milliseconds
   4) Have a maximum value of 65,535 milliseconds
   5) Have a step value of 1 millisecond
   6) Have a default value of 250 milliseconds
   7) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.19 HDLC Channel Number (ID = 19)

a) The HDLC channel number parameter **shall**$_{(471)}$:
   1) Set the HDLC channel for the MDR receiver or MDR transmitter to use to communicate with the RIU (for DACS operation where many MDRs are collocated), as per Section 3.2.1.7.1
   2) Be a range of 5 values
   3) Have a minimum value of 1
   4) Have a maximum value of 5
   5) Have a step value of 1
   6) Have a default value of 1
   7) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.20 Transmission Timeout (AM) (ID = 20)

a) The transmission timeout (AM) parameter **shall**$_{(472)}$:
   1) Set the MDR transmitter timeout value or disable the timeout timer as per Section 3.2.2.2.2.2
   2) Be in seconds
   3) Have a minimum value of 0 seconds (disabled)
   4) Have a maximum value of 300 seconds
   5) Have a step value of 5 seconds
   6) Have a default value of 35 seconds
   7) Be applicable to the MDR transmitter
   8) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.21 Squelch Enable/Disable (AM) (ID = 21)

a) The squelch enable/disable parameter **shall**$_{(473)}$:
   1) Set whether the squelch function of the MDR receiver (Section 3.2.2.1.16) is active or not
   2) Be two discrete settings: ENABLE or DISABLE
   3) Have a default value of ENABLE
   4) Be applicable to the MDR receiver
   5) Have a format that complies with the MDR/RIU ICD NAS-IC-41033502.

3.2.3.2.21A ATR Switch Mode (ID = 22)

a) The ATR switch mode parameter **shall**$_{(694)}$:
   1) Control the mode of operation for the ATR switch
   2) Be two discrete values: Static or Dynamic
   3) Have a default value of: Static
   4) Be applicable to the MDR transmitters
   5) Have a message/bit fromat that complies with the MDR/ICU ICD NAS-IC-41033502.

3.2.3.2.22 Request Read Back (ID = 30)

a) The request read back parameter **shall**$_{(474)}$:
   1) Cause the MDR receiver or MDR transmitter to reply with a radio monitoring message containing the desired monitoring parameter indicated in the Monitoring Parameter ID field, to support Section 3.2.3.3c) and 3.2.3.8
   2) Contain five fields: Monitoring parameter ID, Iterations, Interval, Filter, and Data
   3) Be applicable to the MDR receiver and MDR transmitters
   4) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.23 Audio Input Level (AM) (ID = 31)

a) The audio input level (AM) parameter **shall**$_{(475)}$:
   1) Set the audio input level expected at the main audio output of the MDR transmitter used to set the audio input gain, as per Section 3.2.2.2.4.2
   2) Be power in dBm
   3) Have a minimum value of –25 dBm
   4) Have a maximum value of +20 dBm
   5) Have a step value of 0.5 dB
   6) Have a default value of –8 dBm
   7) Be applicable to the MDR transmitter
   8) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.24 Reserved (ID = 32)

3.2.3.2.25 Reserved (ID = 33)

3.2.3.2.26 MAC Timing Offset Correction (VDL Mode 3) (ID = 34)

a) The MAC timing offset correction (VDL Mode 3) parameter **shall**$_{(476)}$:
   1) Indicate the relative time correction, in microseconds, that should be applied to all MDR M-burst and V/D-burst operations, relative to the previous perceived MAC 6-second epoch in the MDR, which is derived from the receiver T1 framing and Timing Channel from the RIU in support of Section 3.2.1.7.2e and 3.2.1.7.2g
   2) Be timed in microseconds
   3) Have a minimum value of -32768 microseconds
   4) Have a maximum value of 32767 microseconds
   5) Have a step value of 1 microsecond
   6) Have a default value of 0 microseconds
   7) Be applicable to the MDR receivers and MDR transmitters
   8) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.27 Suppress Alert/Alarm (ID = 35)

a) The suppress alert/alarm parameter **shall**$_{(477)}$:
   1) Cause the MDR receiver and MDR transmitter to cease or resume transmitting alert and alarm messages to the MDT or RIU as per Section 3.2.3.3.2
   2) Be two discrete values: Suppress or Normal
   3) Have a default value of Normal
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.28 Reset (ID = 36)

a) The reset parameter **shall**$_{(478)}$:
   1) Have two values: Warm Reset and Factory Reset
   2) Restore all control parameters to their default value and cause the MDR to clear the link and then to transition to the Power Up state (and initiate Power Up sequence) after two Reset (Factory Reset) control parameters are received within 1 second
   3) Cause the MDR to clear the link and then transition to the Power Up state (and initiate Power Up sequence) after two Reset (Warm Reset) control parameters are received within 1 second
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.29 Software Upload Enable/Disable (ID = 37)

a) The software upload enable/disable parameter **shall**$_{(479)}$:
   1) Enable the MDR receiver or MDR transmitter to upload operational software to support the programmability requirements of Sections 3.2.1.4 and 3.2.3.9.3.1
   2) Have two discrete values: Enable Upload and Disable Upload
   3) Have a default value of Disable Upload
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.30 Software Upload (ID = 38)

a) The software upload parameter **shall**$_{(480)}$:
   1) Communicate blocks of the new operational software executable image to reprogram the MDR to support the programmability requirements of Sections 3.2.1.4 and 3.2.3.9.3.1.
   2) Be ignored unless the Software Upload Enable/Disable parameter indicates that an upload is enabled
   3) Not include the Binary Data in the Control reply message
   4) Have Three Fields: Block Number, Total Blocks, Program Binary Block (variable length)
   5) Be applicable to the MDR receiver and MDR transmitters
   6) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.31 Receiver Mute Level (ID = 39)

a) The receiver mute level parameter **shall**$_{(481)}$:
   1) Set the level of attenuation associated with muting a MDR receiver as per Sections 3.2.2.1.12.2c and 3.2.2.1.12.2e
   2) Be three discrete settings: -15dB, -20dB, No Audio
   3) Have a default value of: "No Audio"
   4) Be applicable to the MDR receiver
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.32 Test PTT (ID = 40)

a) The Test PTT parameter **shall**$_{(482)}$:
   1) Key the MDR transmitter continuously while set to "TEST_KEYED" similar to Section 3.2.2.2.12.2
   2) Be two discrete settings: "TEST_KEYED" or "NOT_TEST_KEYED"
   3) Have a default value of "NOT_TEST_KEYED"
   4) Be applicable to the MDR transmitter
   5) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.33 Public Key Maintenance (ID = 41)

a) The Public Key Maintenance parameter **shall**$_{(532)}$:
   1) Allow the MDT/RIU to add or delete MDR-stored public keys as per Section 3.2.3.9.2c
   2) Have six fields: Time/Date, User, User Terminal, Add/Subtract Indicator, Key ID, Key, Security Token
   3) Be applicable to the MDR receiver and MDR transmitter
   4) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.2.34 T2 (Link Retransmission Timer) (ID = 42)

a) The T2 parameter **shall**$_{(584)}$:
   1) Set the link retransmission timer as defined in Section 3.2.1.6.3c
   2) Be in seconds

3) Have a minimum value of 1 second
4) Have a maximum value of 10 seconds
5) Have a step value of 1 second
6) Have a default value of 5 seconds
7) Be applicable to both MDR transmitters and MDR receivers
8) Have a message/bit format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.3 MDR Monitoring and Reporting

a) The MDR monitoring function **shall**$_{(169)}$ perform real-time system performance monitoring and provide real-time system performance reporting when the MDR is in the Offline or Online state , and when the MDR is in Recovery state in accordance with Section 3.2.3.3.b and the Recovery state definition in Section 6.2.15.
b) The MDR **shall**$_{(585)}$ only support those Monitoring and Reporting functions to which it can report within specified tolerances when in the Recovery state.
c) Reserved
d) There **shall**$_{(171)}$ be three instances where monitoring messages are sent to the local MDT and to the RIU:
   1) Upon request via a Control message with parameter ID #30,
   2) When an alert or alarm threshold is crossed, and
   3) When a monitored parameter returns to a value within the normal range
e) The alert or alarm status messages **shall**$_{(172)}$ be sent within 4 seconds of when the parameter being monitored crosses the threshold level.

3.2.3.3.1 Non-Congesting Monitoring

a) The MDR **shall**$_{(173)}$ monitor automatically on a continuous basis without blocking or delaying operational communications and management and without the need for the insertion of an external command.
b) The MDR monitoring **shall**$_{(174)}$ not cause the MDR function to degrade below requirements during operation of the system.
c) Regardless of the frequency of alarm and alert status messages, the MDR monitoring **shall**$_{(175)}$ not prevent the reception and processing of commands.

3.2.3.3.2 Alarm/Alert Monitoring Suppression

a) The MDR receiver and transmitter **shall**$_{(176)}$ suppress alarm and alert status messages to the MDT and RIU upon command.
b) The MDR receiver and transmitter **shall**$_{(177)}$ send the alert event acknowledging the command to suppress alarm and alert status messages before suppressing alarm and alert radio monitoring messages.

3.2.3.4 Alarm/Alert Processing

a) The MDR parameters to be monitored **shall**$_{(179)}$ be described by three monitored parameter states:

1) Normal
2) Alert
3) Alarm

b) The monitored parameter states **shall**$_{(180)}$ be defined by a range of values that are adjoined such that the value range of the alert state is bordering on the normal state at one end of its range and the alarm state on the other side of its range. Figure 3-2 illustrates Normal, Alert and Alarm Range for a Parameter that has both an upper and lower alert and alarm range.

Note: Monitored parameters may have alarm/alert ranges on both sides of the normal range, on just one side, and may have both alert ranges and alarms ranges, or just an alarm or an alert range.

c) A monitored parameter **shall**$_{(586)}$ change state when the monitored parameter value transitions from a value within one range to a value within another range, if applicable for the parameter.

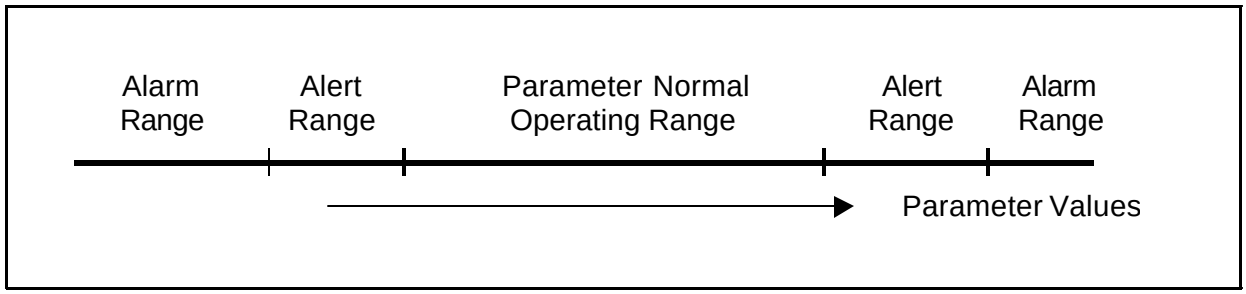


Figure 3-2: Illustration of Normal, Alert and Alarm Range for a Parameter

d) The MDR **shall**$_{(182)}$ determine the change between normal state, alert state, and alarm state of MDR status parameters by comparing data to pre-established thresholds.
e) The MDR **shall**$_{(587)}$ apply a discriminating function (hysteresis) at the boundaries of the ranges to minimize the declaration of alarms and alerts generated under monitored parameter transient conditions.
f) The MDR **shall**$_{(184)}$ automatically declare an alert event when a monitored parameter and/or element status changes to a value that is outside the normal range but within the alert range.
g) The alert event **shall**$_{(185)}$ be reported once per occurrence with the PRI field set to 1.
h) The MDR **shall**$_{(588)}$ not generate spurious alert events in any state or transition.
i) The MDR **shall**$_{(186)}$ automatically declare a return to normal event when a monitored parameter and/or element status that was previously outside the normal range changes to a value that is inside the normal range.
j) The return to normal event **shall**$_{(187)}$ be reported once per occurrence with the PRI field set to 0.
k) The MDR **shall**$_{(188)}$ automatically declare an alarm event when a monitored parameter and/or element status changes to a value crossing from the normal or alert range to the alarm range.
l) The alarm event **shall**$_{(189)}$ be reported once per occurrence with the PRI field set to 2.
m) The MDR **shall**$_{(589)}$ not generate spurious alarm events in any state or transition.

n) The MDR **shall**$_{(190)}$ automatically declare a state change event when the value changes for a monitored parameter and/or element status that indicates a configuration or mode change to the MDR.
o) The MDR State change event **shall**$_{(191)}$ be reported once per occurrence with the PRI field set to 1.
p) The MDR **shall**$_{(193)}$ provide unsolicited radio monitoring message notification within 4 seconds of alarm/alert occurrence. The response time is measured from the time of the alarm/alert-inducing monitored parameter value change to the time the first byte of the notification is reported by the MDR.

Note: Unsolicited radio monitoring messages are alarm/alert/return to normal messages generated by the MDR, without the MDR receiving a readback request, when an alarm, alert or return to normal event occurs.

3.2.3.5 MDR Monitoring Parameters

a) Reserved
b) The MDR receiver and transmitter **shall**$_{(195)}$ monitor the parameters summarized in Table 3-4.

Note: The monitoring parameter value ranges, resolutions, tolerances and default values are summarized in Table 3-4.

Table 3-4: Receiver and Transmitter Monitoring Parameters

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Applica-bility: TX, RX, Both
1	**Event Log**: The Event Log parameter indicates logged events as requested. This parameter is used for the RMMC control point to access the control log of the MDR components.	Discrete fields: Date, MDR ID, Event Log Msg ID, # of Log Entries, Log Entries	N/A	N/A	N/A	N/A	Alert on Log-In; Alert on Log-Out	N/A	Both
2	**Current Frequency**: The Current Frequency parameter indicates the current frequency to which the MDR component is tuned.	Multiple Discrete Frequency Values	112.00 000 MHz	136.97 500 MHz	8 1/3 kHz	N/A	N/A	N/A	Both
3	**Lowest Tunable Frequency**: The Lowest Tunable Frequency value indicates the minimum frequency that the MDR can be tuned.	Multiple discrete frequency values	112.00 000 MHz	118.00 000 MHz	25 kHz	N/A	N/A	N/A	Both
4	**Mode of Operation**: The Mode of Operation (also called system mode) parameter indicates whether the MDR component is in 25kHz DSB-AM, 8.33kHz DSB-AM, or VDL Mode 3 modes.	Three discrete values (represent-ing the modes)	N/A	N/A	N/A	N/A	N/A	N/A	Both
5	**MDR State**: The MDR State parameter indicates that the MDR is in one of six states: Power-Up, Power-Down (if exercised), Online, Offline, Recovery, or Fail.	One of 6 discrete values (states)	-	-	-	N/A	Alert on State change (other than to Fail)	Alarm on Fail	Both
6	**Threshold Setting**: The Threshold Setting Parameter indicates the readback values for alert and alarm threshold settings for a specified parameter..	Set of five fields: ID, Alert low, Alert high, Alarm low, Alarm high	N/A	N/A	N/A	N/A	N/A	N/A	Both
7	**Time**: The Time read back parameter indicates the current time of the real-time clock within the MDR component.	Time in the format MM/DD/YYYY HH:MM:SS.SS	-	-	0.01sec	+/-0.1 sec	N/A	N/A	Both

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Applica-bility: TX, RX, Both
8	**Squelch RF Threshold Level Setting (AM)**: The Squelch RF Threshold Level Setting parameter indicates the RF power settings needed to break the DSB-AM squelch of the MDR Receiver.	Discrete Settings	0	63	1	N/A	N/A	N/A	RX
9	**Squelch Audio Signal-to-Noise Level Setting (AM)**: The receiver Squelch Audio Signal-to-Noise Level Setting parameter indicates the audio signal-to-noise ratio setting	Discrete Settings	0	10	1	N/A	N/A	N/A	RX
10	**Audio Output Level (AM)**: The Audio Output Level indicates the setting of the DSB-AM audio signal power output level in dBm presented to the main audio output of the MDR Receiver.	Power in dBm	-25 dBm	20 dBm	0.5 dB	N/A	N/A	N/A	RX
11	**Receiver Mute (AM)**: The Receiver Mute parameter indicates whenever the MDR Receiver is muted or unmuted for DSB-AM.	Two values: Muted, Unmuted	N/A	N/A	N/A	N/A	N/A	N/A	RX
12	**Power Output Setting (AM)**: The Power Output parameter indicates the setting of the Power Output Parameter. (Top row applies to 15W transmitter, middle row applies to 50W transmitter, and bottom row applies if one transmitter is used for both 15W and 50 W)	Power values in dBm	33 dBm	42 dBm	0.5 dB	+/- 2 dB	N/A	N/A	TX
			40 dBm	47 dBm	0.5 dB				
			33 dBm	47 dBm	0.5 dB				
13	**Transmitter Modulation % Setting (AM)**: The Transmitter Modulation % parameter indicates the setting of the Transmitter Modulation parameter.	Percent	0%	100%	1%	+/- 5%	N/A	N/A	TX
14	**ATR Switch State**: The ATR Switch State parameter indicates the configuration of the ATR switch states in the antenna connection. Two discrete values indicating ATR1 and ATR2.	Two discrete values: ATR1, ATR2	N/A	N/A	N/A	N/A	N/A	N/A	TX

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Applica-bility: TX, RX, Both
15	**Software Version**: The Software Version parameter indicates the current version of the software active in the MDR component, as well as the standby software version.	Pair of fields: One of 255 discrete values	1	255	1	0	N/A	N/A	Both
16	**N1 (Number of Information Bits):** This parameter indicates the maximum number of bits in the information fields.	Number of Bits	128	4096	8	N/A	N/A	N/A	Both
17	**T1 (Link Response Timer):** This parameter indicates the link response timer.	ms	100	500	1	N/A	N/A	N/A	Both
18	**T3 (Reassembly Timer):** This parameter indicates the reassembly timer.	ms	50	65,535	1	N/A	N/A	N/A	Both
19	**HDLC Channel Number**: This parameter indicates the HDLC channel to use for the MDR per NAS-IC-41033502.	Five Discrete numbers	1	5	1	N/A	N/A	N/A	Both
20	**Transmission Timeout Setting (AM)**: indicates the setting of the Transmission Timeout control parameter.	Seconds	0 sec (Disabled)	300 sec	5 sec	0.5 sec	N/A	N/A	TX
21	**Squelch Enable/Disable (AM)**: The Squelch Status parameter indicates the setting of the Squelch Enable/Disable control parameter.	Two Discrete Values: Enable, Disable	N/A	N/A	N/A	N/A	N/A	N/A	RX
22	**ATR Switch Mode:** The ATR Switch Mode parameter indicates the mode of operation for the ATR switch.	Two Descrete Values: Static, Dynamic	N/A	N/A	N/A	N/A	N/A	N/A	TX
30	**RESERVED**								
31	**Audio Input Level Setting (AM):** The Audio Input Level Setting parameter indicates the setting of the Audio Input Level parameter	Power In dBm	-25	+20	0.5dB	N/A	N/A	N/A	TX
32	**RESERVED**								
33	**RESERVED**								
34	**MAC Timing Offset Correction Setting:** The MAC Timing Offset Correction Setting parameter indicates the setting of the MAC Timing Offset Correction parameter	Time in µs	-32768	+32767	1	N/A	N/A	N/A	Both

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Applica-bility: TX, RX, Both
35	**Suppress Alarm/Alert Setting:** The Suppress Alarm/Alert Setting parameter indicates whether Alarms and Alerts are suppressed or enabled	Two discrete values: Suppress, Normal	N/A	N/A	N/A	N/A	N/A	N/A	Both
36	**RESERVED**								
37	**Software Upload Setting:** The Software Upload Setting parameter indicated whether software uploading is prohibited or enabled	Two discrete values: Enable Upload, Disable Upload	N/A	N/A	N/A	N/A	N/A	N/A	Both
38	**RESERVED**								
39	**Receiver Mute Level Setting –** indicates the setting of the Receiver Mute Level parameter	Thre Discrete values: -15 dB, -20 dB, no audio	N/A	N/A	N/A	N/A	N/A	N/A	RX
40	**PTT Setting**: The PTT Setting parameter indicates whether the PTT is keyed (via User or Control) or not	Three discrete values: USER_ KEYED, TEST_ KEYED, NOT_ KEYED	N/A	N/A	N/A	N/A	N/A	N/A	TX
41	**Public Key List:** The Public Key List parameter reports the list of public keys stored in the MDR	MDR ID Number, (Key ID, Key) x 10	N/A	N/A	N/A	N/A	Alert on Public Key Addition	N/A	Both
42	**T2 (Link Retransmission Timer):** This parameter indicates the setting of the link retransmission timer used in link clearing.	Seconds	1 sec	10 sec	1 sec	N/A	N/A	N/A	Both
50	**MDR ID Number**: The MDR ID Number parameter indicates the unique identification number assigned to the LRU(s) of the MDR component.	Discrete numerical values	1	16777 215	1	N/A	N/A	N/A	Both
51	**RF Input Power Level (AM)**: The receiver RF Input Power Level parameter indicates the estimate of the received signal level present at the MDR RF input.	Power values in dBm	-110 dBm	+15 dBm	1 dB	+/-3 dB	> -7 dBm	> +13 dBm	RX

ID	Parameter	Type	Min	Max	Reso-lution (Step Size)	Tolerance (Acceptable Error)	Alert Values	Alarm Values	Applica-bility: TX, RX, Both
52	**Squelch Break Status (AM)**: The Squelch Break Status parameter indicates whenever the MDR Receiver determines a valid transmission is being received. For DSB-AM operation, this is achieved by the RF signal exceeding the squelch thresholds.	Two discrete values: Squelch Broken, Not Broken	-	-	-	N/A	N/A	N/A	RX
53	**In-Service Time** : The In-Service Time parameter indicates the number of hours the MDR component has been powered.	Hours	0 hrs	2^{24}-1 hrs	1 hr	+/-1hr	N/A	N/A	Both
54	**RIU Timing Offset Change (VDL Mode 3)**: The RIU Timing Offset Change parameter indicates whenever the RIU's timing reference varies more than 10 µs for the MDR component. This is used to identify if there has been a timing slip on the RIU/MDR link.	Two discrete values: Yes – there is a time slip No – there is no time slip	N/A	N/A	N/A	N/A	ALERT on time slip	N/A	Both
55	**Transmit Antenna VSWR**: The Transmit Antenna VSWR parameter indicates whether the VSWR of the transmit antenna is within an acceptable operating range.	Two Discrete Values: Good, Bad	N/A	N/A	N/A	N/A	N/A	Bad (>= 3:1)	TX
56	**RESERVED**								
57	**Measured Power Output (AM):** The Measured Power Output parameter indicates the current, actual RF transmission power at the MDR RF output. (Top row applies to 15W transmitter, middle row applies to 50W transmitter, and bottom row applies if one transmitter is used for both 15 & 50 W)	Power in dBm	30 dBm	45 dBm	0.5 dB	+/-2 dB	N/A	+/-2 dB of Power Output setting	TX
			37 dBm	50 dBm	0.5 dB				
			30 dBm	50 dBm	0.5 dB				
58	**Measured Transmitter Modulation %:** The Measured Transmitter Modulation % parameter indicates the current percentage of transmitter modulation	Percentage	0 %	100 %	1 %	+/- 5 %	N/A	> 99 %	TX

Notes:

1. The parameter ID corresponds to the CTYPE field as defined in NAS-41033502.
2. Values in the upper row of ID #12 and 57 are for the 15W max transmitter configuration, values in the middle row are for the 50 W max transmitter configuration, and values in the bottom row are applicable if a single transmitter enclosure is used to fulfill the requirements of both the 15W and the 50W transmitters.
3. For monitoring parameters ID#12, 13 and 20 the MDR must operate plus or minus the tolerance listed for the specified parameter (not the accuracy of the readback of the setting). For example, for ID#20, the MDR must cause a transmitter timeout within +/- 0.5 seconds of the Transmitter Timeout parameter setting.

3.2.3.5.1 Event Log (ID = 1)

a) The Event log parameter **shall**$_{(485)}$:
   1) Indicate events logged by the MDR in the Event Log that match the event criteria as requested and specified by the RIU or MDT
   2) Include the following fields: Date/Time, MDR ID, Event Log Message ID, Number of Log Entries, and Log Entries
   3) Have an alert value whenever a Log-In or Log-Out event occurs
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.2 Current Frequency (ID = 2)

a) The current frequency parameter **shall**$_{(486)}$:
   1) Indicate the current frequency to which the MDR receiver or MDR transmitter is tuned as per Section 3.2.1.1.1
   2) Be a frequency readout
   3) Have a minimum value of 112.00000 MHz
   4) Have a maximum value of 136.97500 MHz
   5) Have a resolution (step size) of 8 1/3 kHz
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.3 Lowest Tunable Frequency (ID = 3)

a) The lowest tunable frequency parameter **shall**$_{(487)}$:
   1) Indicate the channel label for the minimum frequency that the MDR receiver or MDR transmitter can be tuned as per Section 3.2.1.1.1b
   2) Be multiple discrete frequency values
   3) Have a minimum value of 112.00000 MHz
   4) Have a maximum value of 118.00000 MHz
   5) Have a resolution (step size) of 25 kHz
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.4 Mode of Operation (ID = 4)

a) The mode of operation (also called system mode) parameter **shall**$_{(488)}$:
   1) Indicate the mode of operation for the MDR receiver or MDR transmitter as per Section 3.2.1.1
   2) Be one of 3 values representing the modes: 25 kHz DSB-AM, 8.33 kHz DSB-AM, or VDL Mode 3 modes
   3) Be applicable to the MDR receiver and MDR transmitters
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.5 MDR State (ID = 5)

a) The MDR state parameter **shall**$_{(489)}$:
   1) Indicate the MDR receiver or MDR transmitter is in one of six states as per Section 3.2.1.5
   2) Be one of 6 discrete values: Offline, Online, Power Up, Power Down (if exercised), Recovery, or Fail
   3) Have an alarm value if transition to Fail state
   4) Have an alert value for other state transitions
   5) Be applicable to the MDR receiver and MDR transmitters
   6) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.6 Threshold Setting (ID = 6)

a) The parameter threshold value parameter **shall**$_{(490)}$:
   1) Indicate the threshold settings for the MDR transmitter or MDR receiver parameters as per Section 3.2.3.4
   2) Be one of variable values
   3) Be applicable to the MDR receiver and MDR transmitters
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.7 Time (ID = 7)

a) The time readback parameter **shall**$_{(491)}$:
   1) Indicate the current time within the MDR receiver or MDR transmitter to support Section 3.2.3.6
   2) Be in a format of MM/DD/YYYY HH:MM:SS.SS
   3) Have a resolution (step size) of 0.01 second
   4) Have a tolerance (acceptable error) of ±0.1 second
   5) Reserved
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.8 Squelch RF Threshold Level Setting (AM) (ID = 8)

a) The squelch RF threshold level setting parameter **shall**$_{(492)}$:
   1) Indicate the RF power settings needed to break the DSB-AM squelch of the MDR receiver as per 3.2.2.1.16

2) Be discrete values
3) Have a minimum value of 0
4) Have a maximum value of 63
5) Have a resolution (step size) of 1
6) Be applicable to the MDR receiver
7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.9 Squelch Audio Signal-to-Noise Threshold Level Setting (AM) (ID = 9)

a) The squelch audio signal-to-noise threshold level setting parameter **shall**$_{(590)}$:
   1) Indicate the audio signal-to-noise ratio setting of the MDR receiver as per 3.2.2.1.16
   2) Be discrete values
   3) Have a minimum value of 0
   4) Have a maximum value of 10
   5) Have a resolution (step size) of 1
   6) Be applicable to the MDR receiver
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.10 Audio Output Level Setting (AM) (ID = 10)

a) The audio output level setting (AM) parameter **shall**$_{(493)}$:
   1) Indicate the setting of the audio output level parameter of the MDR receiver as per Section 3.2.2.1.9
   2) Be power in dBm
   3) Have a minimum value of –25 dBm
   4) Have a maximum value of 20 dBm
   5) Have a resolution (step size) of 0.5 dB
   6) Be applicable to the MDR receiver
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.11 Receiver Mute (AM) (ID = 11)

a) The receiver mute (AM) parameter **shall**$_{(494)}$:
   1) Indicate whenever the MDR receiver is muted or unmuted for DSB-AM as per Section 3.2.2.1.12.2
   2) Be one of 2 values: Muted or Unmuted
   3) Be applicable to the MDR receiver
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.12 Power Output Setting (AM) (ID = 12)

a) The power output setting parameter **shall**$_{(495)}$:
   1) Indicate the setting of the Power Output parameter of the MDR transmitter as per Section 3.2.2.2.5.2
   2) Be a power level in dBm

3) Have a minimum value for the 15 watt MDR transmitter configuration of 33 dBm
4) Have a minimum value for the 50 watt MDR transmitter configuration of 40 dBm
5) Have a minimum value of 33 dBm if a single MDR transmitter enclosure is used for both 15W and 50W requirements
6) Have a maximum value for the 15 watt MDR transmitter configuration of 42 dBm
7) Have a maximum value for the 50 watt MDR transmitter configuration of 47 dBm
8) Have a maximum value of 47 dBm if a single MDR transmitter enclosure is used for both 15W and 50W requirements.
9) Have a resolution (step size) of 0.5 dB for all transmitter configurations
10) Reserved
11) Be applicable to the MDR transmitters
12) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.13 Transmitter Modulation % Setting (AM) (ID = 13)

a) The transmitter modulation % setting parameter **shall**$_{(497)}$:
   1) Indicate the setting of the Transmitter modulation % parameter of MDR transmitter as described in Section 3.2.2.2.4
   2) Be in percent
   3) Have a minimum value of 0 percent
   4) Have a maximum value of 100 percent
   5) Have at least 100 steps
   6) Have a tolerance (acceptable error) of ±5 percent
   7) Be applicable to the MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.14 ATR Switch State (ID = 14)

a) The ATR switch state parameter **shall**$_{(498)}$:
   1) Indicate the state of the ATR switch to the antenna
   2) Be one of two discrete values: ATR1 or ATR2
   3) Reserved
   4) Be applicable to the MDR transmitters
   5) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.15 Software Version (ID = 15)

a) The software version parameter **shall**$_{(499)}$:
   1) Indicate the current version of the software active in the MDR receiver or MDR transmitter, as well as the version number of the standby software version, to support the programmability requirements of Section 3.2.1.4
   2) Be one of 255 discrete values for each field
   3) Have a minimum value of 1
   4) Have a maximum value of 255

5) Use a value of 0 to indicate an invalid or non-existent version
6) Have a resolution (step size) of 1
7) Have a tolerance (acceptable error) of 0
8) Be applicable to the MDR receiver and MDR transmitters
9) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.16 N1 (Number of Information Bits) (ID = 16)

a) The N1 parameter **shall**$_{(500)}$:
   1) Indicate the maximum number of bits in the information fields as described in Section 3.2.1.6.3a
   2) Be the value in bits
   3) Have a minimum value of 128
   4) Have a maximum value of 4096
   5) Have a resolution (step size) of 8
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.17 T1 (Link Response Timer) (ID = 17)

a) The T1 parameter **shall**$_{(501)}$:
   1) Indicate the link response time as described in Section 3.2.1.6.3b
   2) Be a value in milliseconds
   3) Have a minimum value of 100 milliseconds
   4) Have a maximum value of 500 milliseconds
   5) Have a resolution (step size) of 1 millisecond
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.18 T3 (Reassembly Timer) (ID = 18)

a) The T3 reassembly timer parameter **shall**$_{(502)}$:
   1) Indicate the time value of the T3 reassembly timer as described in Section 3.2.1.6.3d
   2) Be a value in milliseconds
   3) Have a minimum value of 50 milliseconds
   4) Have a maximum value of 65,535 milliseconds
   5) Have a resolution (step size) of 1 millisecond
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.19 HDLC Channel Number (ID = 19)

a) The HDLC channel number parameter **shall**$_{(503)}$:
   1) Indicate the HDLC channel for the MDR receiver or MDR transmitter to use to communicate with the RIU (for DACS operation where many MDRs are collocated) as per Section 3.2.1.7.1
   2) Be a range of 5 values

3) Have a minimum value of 1
4) Have a maximum value of 5
5) Have a resolution (step size) of 1
6) Be applicable to the MDR receiver and MDR transmitters
7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.20 Transmission Time-Out Value (AM) (ID = 20)

a) The transmission time-out value (AM) parameter **shall**$_{(504)}$:
   1) Indicate the current time-out value after which the voice transmission will be terminated by the MDR transmitter as per Section 3.2.2.2.2.2
   2) Be time in seconds
   3) Have a minimum value of 0 seconds
   4) Have a maximum value of 300 seconds
   5) Have a resolution (step size) of 5 seconds
   6) Have a tolerance (acceptable error) 0.5 second
   7) Be applicable to the MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.21 Squelch Enable/Disable (AM) (ID = 21)

a) The squelch enable/disable parameter **shall**$_{(505)}$:
   1) Indicate the squelch break function (Section 3.2.2.1.16) has either activated or deactivated for the DSB-AM modes in the MDR receiver
   2) Be two discrete values: ENABLE or DISABLE
   3) Be applicable to the MDR receiver
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.21A ATR Switch Mode (ID = 22)

a) The ATR switch mode parameter **shall**$_{(695)}$:
   1) Indicate the mode of operation for the ATR switch
   2) Be one of two discrete values: Static or Dynamic
   3) Be applicable to the MDR transmitter
   4) Have a bit/message fromat that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.22 Audio Input Level Setting (AM) (ID=31)

a) The audio input level setting parameter **shall**$_{(591)}$**:**
   1) Indicate the setting of the audio input level parameter as per Section 3.2.2.2.4.2
   2) Be a decimal number representing dBm
   3) Have a minimum value of –25 dBm
   4) Have a maximum value of +20 dBm
   5) Have a resolution (step size) of 0.5 dB
   6) Be applicable to the MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.23 MAC Timing Offset Level Setting (ID=34)

a) The MAC timing offset level setting parameter **shall**$_{(592)}$:
   1) Indicate the setting of the MAC Timing Offset Level parameter as per Sections 3.2.1.7.2e and 3.2.1.7.2g
   2) Be an integer representing microseconds
   3) Have a minimum value of –32768
   4) Have a maximum value of +32767
   5) Have a resolution (step size) of 1
   6) Be applicable to the MDR transmitters and MDR receiver
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.24 Suppress Alarm/Alert Setting (ID=35)

a) The suppress alarm/alert Setting parameter **shall**$_{(593)}$:
   1) Indicate the setting of the Suppress Alarm/Alert parameter as per Section 3.2.3.3.2
   2) Be of two discrete values, either “Suppress” or “Normal”
   3) Be applicable to the MDR transmitters and MDR receiver
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.25 Software Upload Setting (ID=37)

a) The software upload setting parameter **shall**$_{(594)}$:
   1) Indicate the setting of the Software Upload parameter to support the programmability requirements of Section 3.2.1.4
   2) Be of two discrete values, either “Enable Upload” or “Disable Upload”
   3) Be applicable to the MDR transmitters and MDR receiver
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.26 Receiver Mute Level Setting (ID=39)

a) The receiver mute level setting parameter **shall**$_{(662)}$:
   1) Indicate the setting of the Receiver Mute Level parameter as per Sections 3.2.2.1.12.2c and 3.2.2.1.12.2e
   2) Be of three discrete values, either “-15 dBm”, “-20 dBm” or “No Audio”
   3) Be applicable to the MDR receiver
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.27 PTT Setting (ID=40)

a) The PTT setting parameter **shall**$_{(663)}$:
   1) Indicate the PTT setting of the transmitter as per Section 3.2.2.2.12.
   2) Be of three discrete values:"USER_KEYED", “TEST_KEYED” or “NOT_KEYED”
   3) Be applicable to the MDR transmitters
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.28 Public Key List (ID = 41)

a) The public key list parameter **shall**$_{(668)}$:
   1) Indicate the public keys that are stored by the MDR as per Section 3.2.3.9.2c
   2) Include the following fields: MDR ID Number, and ten sets of Key ID and Key
   3) Be applicable to the MDR receiver and MDR transmitters
   4) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.29 T2 (Link Retransmission Timer) (ID = 42)

a) The T2 parameter **shall**$_{(597)}$:
   1) Indicate the link retransmission time as described in Section 3.2.1.6.3c
   2) Be a value in seconds
   3) Have a minimum value of 1 seconds
   4) Have a maximum value of 10 seconds
   5) Have a resolution (step size) of 1 second
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.30 MDR ID Number (ID = 50)

a) The MDR ID number parameter **shall**$_{(506)}$:
   1) Indicate the unique identification number assigned to the MDR receiver or MDR transmitter
   2) Be discrete numerical values
   3) Have a minimum value of 1
   4) Have a maximum value 16,777,215
   5) Have a resolution (step size) of 1
   6) Be applicable to the MDR receiver and MDR transmitters
   7) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.31 RF Input Power Level (AM) (ID = 51)

a) The RF input power level parameter **shall**$_{(507)}$:
   1) Indicate an estimate of the received signal level present at the MDR RF input to support Section 3.2.2.1.21
   2) Be power values in dBm
   3) Have a minimum value of –110 dBm
   4) Have a maximum value of 15 dBm
   5) Have a resolution (step size) 1 dB
   6) Have a tolerance (acceptable error) of ±3 dB
   7) Have an alert value of greater than –7 dBm
   8) Have an alarm value of greater than +13 dBm
   9) Be applicable to the MDR receiver
   10) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.32 Squelch Break Status (AM) (ID = 52)

a) The squelch break status (AM) parameter **shall**$_{(508)}$:
   1) Indicate whenever the MDR receiver determines a valid transmission is being received as per Section 3.2.2.1.16
   2) For DSB-AM operation, this is achieved by the RF signal exceeding the squelch thresholds
   3) Be two discrete values: Squelch Broken or Not Broken
   4) Be applicable to the MDR receiver
   5) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.33 In-Service Time (ID = 53)

a) The in-service time parameter **shall**$_{(509)}$:
   1) Indicate the number of hours the MDR receiver or MDR transmitter have been continuously powered to support Section 3.5.1.1
   2) Be provided in hours
   3) Have a minimum value of 0 hours
   4) Have a maximum value of 2^{24}-1 hours
   5) Have a resolution (step size) of 1 hour
   6) Have a tolerance (acceptable error) of $\pm$1 hour
   7) Be applicable to the MDR receiver and MDR transmitters
   8) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.34 RIU Timing Offset Change (VDL Mode 3) (ID = 54)

a) The RIU timing offset change (VDL Mode 3) parameter **shall**$_{(510)}$:
   1) Indicate whenever the RIU's timing reference varies more than 10 microseconds for the MDR receiver or MDR transmitter as per Section 3.2.1.7.2g
   2) Be two discrete values: Yes (there is a time slip) or No (there is no time slip)
   3) Have an alert value to Alert on time slip
   4) Be applicable to the MDR receiver and MDR transmitters
   5) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.35 Transmit Antenna VSWR (ID = 55)

a) The transmit antenna VSWR parameter **shall**$_{(511)}$:
   1) Indicate whether the VSWR of the transmit antenna path is acceptable as per Section 3.2.2.2.5
   2) Be one of two discrete values: Good or Bad
   3) Have an alarm value of Bad, defined as when the VSWR equals or exceeds 3:1.
   4) Be applicable to the MDR transmitters
   5) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.36 Reserved (ID = 56)

3.2.3.5.37 Measured Power Output (AM) (ID = 57)

a) The measured power output parameter **shall**$_{(664)}$:
   1) Indicate the current RF transmission power at the MDR RF output of the MDR transmitter to support Section 3.2.2.2.5.2
   2) Be a power level in dBm
   3) Have an alarm setting of 0 that disables the measurement
   4) Have a minimum value for the 15 watt MDR transmitter configuration of 30 dBm
   5) Have a minimum value for the 50 watt MDR transmitter configuration of 37 dBm
   6) Have a minimum value of 30 dBm if a single MDR transmitter enclosure is used for both 15W and 50W requirements
   7) Have a maximum value for the 15 watt MDR transmitter configuration of 45 dBm
   8) Have a maximum value for the 50 watt MDR transmitter configuration of 50 dBm
   9) Have a maximum value of 50 dBm if a single MDR transmitter enclosure is used for both 15W and 50W requirements
   10) Have a resolution (step size) of 0.5 dB for all MDR transmitter configuration
   11) Reserved
   12) Have a tolerance (acceptable error) of ±2 dB for all MDR transmitters
   13) Have an alarm value of ±2 dB of the Power Output Setting (ID 12)
   14) Be applicable to the MDR transmitters
   15) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.5.38 Measured Transmitter Modulation (AM) (ID = 58)

a) The measured transmitter modulation % parameter **shall**$_{(665)}$:
   1) Indicate the actual Transmitter modulation % of the MDR transmitter in support of Section 3.2.2.2.4
   2) Be in percent and averaged over 3 second PTT intervals
   3) Have an alarm setting of 0 that disables the measurement
   4) Have a minimum value of 0 percent
   5) Have a maximum value of 100 percent
   6) Have at least 100 steps
   7) Have a tolerance (acceptable error) of ±5 percent
   8) Have an alarm value of greater than 99 percent
   9) Be applicable to the MDR transmitters
   10) Have a bit/message format that complies with the MDR/RIU ICD NAS-IC-41033502

3.2.3.6 Logging Requirements

a) The MDR **shall**$_{(595)}$ log the following events:
   1) State change events, defined as the transition from one state to any other state
   2) Log-in/Log-out events, defined as the receipt of control parameter ID#1, or automatic logout
   3) Control events, defined as receipt of any control parameter command except ID#30, Request Readback , and ID#1, Log In/Log Out.
   4) Failure events, defined as the detection of any failure

5) Alarm/Alert/Return to Normal events, defined as a monitored parameter crossing of any active alarm or alert threshold

3.2.3.6.1 Automatic State Transition Log Entry

a) For Automatic state transitions, the MDR **shall**$_{(596)}$ log the:
   1) Event Type as Automatic State Change
   2) FROM state
   3) TO state and
   4) Date/time (of transition).
b) The Event Type field **shall**$_{(699)}$ contain a coded indication of the event type.

3.2.3.6.2 Manual State Transition Log Entry

a) For Manual state transitions, the MDR **shall**$_{(598)}$ log the:
   1) Event Type as Manual State Change
   2) FROM state
   3) TO state
   4) Date/time (of transition)
   5) User Identification and
   6) User Terminal Identification.
b) User Terminal field **shall**$_{(599)}$ indicate the MDT identification or the Remote User Terminal identification.

3.2.3.6.3 Log-In / Log-Out Log Entry

a) For Log-in/Log-out events, the MDR **shall**$_{(600)}$ log the:
   1) Event Type as Log-in/Log-out
   2) Date/Time
   3) Session Action
   4) User Identification
   5) User Terminal identification
   6) Authentication Result
b) The Session Action field **shall**$_{(601)}$ indicate whether the Log-In/Log-Out Event was a Log-In, Commanded Log Out, or Automatic Log-Out.
c) Authentication Result field **shall**$_{(602)}$ indicate whether the Digital Signature associated with the Log- In was authenticated or rejected.

3.2.3.6.4 Control Event Log Entry

a) For Control events, the MDR **shall**$_{(603)}$ log the:
   1) Event Type as Control
   2) Control Parameter ID
   3) Control Parameter BEFORE value
   4) Control Parameter value except software update payload
   5) Date/time (of Control command receipt)

6) User Identification
7) User Terminal identification
8) MDR Response.

b) The MDR Response field **shall**$_{(604)}$ indicate whether the MDR accepted or rejected the control parameter command.

c) If the MDR rejects the control parameter command, the MDR Response field **shall**$_{(605)}$ be contain the error code.

3.2.3.6.5 Failure Event Log Entry

a) For Failure events, the MDR **shall**$_{(606)}$ log the:
1) Event Type as Failure
2) FROM state
3) TO state (Recovery or Failed)
4) Failure code, and
5) Date/time (of Failure).

b) The Failure code field **shall**$_{(607)}$ contain text or numeric codes to indicate the specific failure type.

3.2.3.6.6 Alarm/Alert/Return to Normal (RTN) Log Entry

a) For Alarm/Alert/RTN events, the MDR **shall**$_{(608)}$ log the:
1) Event Type as Alarm/Alert/RTN
2) Monitored Parameter ID
3) Monitored Parameter value, and
4) Date/time (of Alarm/Alert/RTN).

b) The Event Type field **shall**$_{(609)}$ be coded to indicate whether the event was an Alarm, an Alert or a Return to Normal.

3.2.3.6.7 MDT Log Maintenance

a) The MDR **shall**$_{(610)}$ log at least 1000 events, in any combination of events, and log events on a First In, First Out basis.

b) The MDR log and log entries **shall**$_{(611)}$ be retained while the MDR is any state, including OFF state, and through any transition, including power loss and restoral, for the life of the MDR receiver and transmitters.

c) The MDR log entries **shall**$_{(612)}$ be retained until over-written by a valid log entry.

3.2.3.7 RESERVED

3.2.3.8 Event Log Readback

a) The MDR **shall**$_{(659)}$ reply to a Control Parameter #30, Request Readback containing ID=1, (Event Log) with the Event Log entries that match the Filter and Data criteria, as follows:

FILTER	DATA	MDR reads back in (a series of) ID#1 Radio Monitoring Messages:
All	-	all event log entries
All	Date/Time	all event log entries since Date/Time
State Change	-	all state change event log entries
State Change	Date/Time	all event log entries since Date/Time
Control	-	all control event log entries
Control-DT	Date/Time	all control event log entries since Date/Time
Control-ID	ID	all control event log entries with Control parameter ID specified
Failure	-	all failure event log entries
Alarm/Alert/RTN	-	all alarm/alert/RTN event log entries
Alarm/Alert/RTN-DT	Date/Time	all alarm/alert/RTN event log entries since Date/Time
Alarm/Alert/RTN-ID	ID	all alarm/alert/RTN event log entries with alarm/alert/RTN set against Monitored parameter ID specified
Log-In/Log-Out	-	all log-in/log-out event log entries
Log-In/Log-Out	Date/Time	all log-in/log-out event log entries since Date/Time

3.2.3.9 INFOSEC Requirements

3.2.3.9.1 Verification

a) The MDR **shall**$_{(513)}$ verify the authenticity, integrity and time validity of the digital signed information received via the MDT or RIU interfaces.
b) The digital signature algorithm that performs this verification **shall**$_{(514)}$ correspond to at least one of the algorithms defined in FIPS 186-2.
c) The digital signature function **shall**$_{(515)}$ meet or exceed security level 1 as defined in FIPS 140-1.
d) The digital signature function **shall**$_{(516)}$ be validated according to FIPS 140-1 by an accredited FIPS 140-1 testing laboratory.

3.2.3.9.2 Keys

a) The MDR **shall**$_{(517)}$ provide storage for 10 public keys, any of which may be used in verifying the digital signature defined in 3.2.3.9.1.
b) The storage for public keys **shall**$_{(518)}$ be in non-volatile memory and be maintained through power loss and restoral.
c) The MDR **shall**$_{(519)}$ provide a mechanism to add and delete public keys via the MDT or RIU interface.

3.2.3.9.3 Security Procedures

a) All control parameter commands, except ID#30 Request Readback, **shall**$_{(520)}$ be accepted only if the requesting device establishes a Control session, by providing a valid digitally signed authorization token (“security token”).

Note: The Request Readback control parameter is the only control parameter that the MDR will accept when no Control session has been established.

Note: The "security token" will consist of the MDT- or RIU-supplied, FAA-generated digital signature of an FAA-selected data field. The FAA-selected data field that may be unique to each User Terminal.

b) All control parameter commands, except ID#30 Request Readback, received without establishment of, or outside of, a Control session, or are associated with a security token that fails digital signature verification, **shall**$_{(523)}$ be rejected.
c) The MDR **shall**$_{(521)}$ receive and authenticate the security token each time an RIU or MDT logs in.

Note: Security procedures apply to Control sessions only. These security requirements apply to the MDR processing of control parameters, not to the MDR transmitter's processing of messages intended only for the RF transmission, nor to the MDR receiver's output of received RF information to the RIU.

3.2.3.9.3.1 Software Upload Security

a) Software uploads that are not digitally signed or contain an invalid digital signature **shall**$_{(522)}$ be rejected.

Note: The Software Upload control parameter (ID#38) message will contain, in the last delivered program binary block, a digital signature appended to the software binary image as a signature specifically for the software image contained in the program binary blocks.

b) RESERVED
c) If the Software Upload capability is still enabled when a user's control session is ended, the Software Upload parameter shall be set to disabled.

3.2.3.9.3.2 Control Session

a) The MDR **shall**$_{(669)}$ initiate a control session upon successful authentication of RIU or MDT log on / security token.
b) As long as a valid session is active on one control interface, the MDR **shall**$_{(526)}$ reject all control parameters from the other control interface.
c) The MDR **shall**$_{(527)}$ terminate the control session upon log-out, MDT disconnection or after no control parameter is received within 30 minutes.

Note: An RIU or MDT will log in to initiate a Control session. A session is initiated after receipt of a Log-In and authentication of a security token. A session ends with a log-out, physical disconnection of an MDT, or when no Control Parameters are received within 30 minutes. A session is used by the RIU or MDT to convey control parameters, and receive both control replies and solicited radio monitoring messages. A control session is not required for unsolicited radio monitoring messages. The RIU will automatically log out (discontinue the control session) when it has completed sending control parameters.

3.2.3.9.4 Boot Cycle

a) The MDR boot cycle or equivalent **shall**$_{(528)}$ be secured such that the possibility of an illegitimate reconfiguration of the MDR operating software during the boot cycle or equivalent is extremely low.

3.2.3.10 Vendor Built In Test

a) The vendor **shall**$_{(211)}$ make its built-in test accessible to the FAA.

3.2.3.11 Reserved

3.2.3.12 MDR Failure Detection and Reporting

a) The MDR **shall**$_{(666)}$ detect and report critical equipment failures to the local and remote MMC access points automatically when the MDR is in the Offline and Online states, and during Recovery.

Note: See Section 6.2.17 for definitions of critical and non-critical equipment failures.

3.3 Interfaces

3.3.1 Legacy Interfaces Between RCE and MDR

a) MDR receiver and transmitter equipment **shall**$_{(212)}$ support the existing interfaces for remote receiver interfaces, remote transmitter interfaces, local receiver audio and local microphone.

3.3.1.1 Radio Frequency (RF) Connectors

a) External Radio Frequency (RF) connectors **shall**$_{(213)}$ be 50 ohm coaxial type N female.

3.3.1.1.1 MDR RF Connector

a) The MDR RF connector **shall**$_{(227)}$ be used for the transmitter output and receiver input.

3.3.1.1.2 FILTER IN Connector

a) The FILTER IN connector **shall**$_{(615)}$ be used for the input to the internal filter.

3.3.1.1.3 FILTER OUT Connector

a) The FILTER OUT connector **shall**$_{(616)}$ be used for the output from the internal filter.

3.3.1.1.4 ATRC Connector

a) The ATRC connector **shall**$_{(617)}$ be used for the antenna connection in the configurations based on Section 3.2.2.2.14 (see example configuration in Figure 6-1).

3.3.1.1.5 ATR1 Connector

a) The ATR1 connector **shall**$_{(618)}$ be used for the remote MDR connection in the configurations based on Section 3.2.2.2.14 (see example configuration in Figure 6-1).

3.3.1.1.6 ATR2 Connector

a) The ATR2 connector **shall**$_{(619)}$ be used for the local MDR connection in the configurations based on Section 3.2.2.2.14 (see example configuration in Figure 6-1).

3.3.1.2 Electrical Input Power Connectors

a) Electrical input power connectors **shall**$_{(214)}$ be of the following male types: two-conductor polarized for DC inputs and three-conductor National Electrical Manufacturers Association (NEMA) type for AC inputs.
b) Both power connectors **shall**$_{(215)}$ conform to FAA-G-2100. Commercial equivalent connectors are acceptable if available.

3.3.1.3 Receiver Remote Connector

a) This electrical connector **shall**$_{(216)}$ be located on the rear of the MDR receiver.
b) Signals and their levels **shall**$_{(217)}$ be as below:

Receiver Remote Connector				
Signal	**Level**	**Impedance (Ohms)**	**Input / Output**	**Notes**
Voice Audio	As per the setting for Parameter ID#10	600 ± 60	Output	
Receiver Mute	0 VDC ± 1 V (Ground) – Muted Open – No Mute		Input	10 mA max. <40 VDC Grounded for duration of Mute
Receiver Mute Confirmation	Short-circuit = Confirm, Open = No Confirm		Output	1 Amp max, <80 VDC
Squelch Break	Short-circuit = active, Open = Not active		Output	1 Amp max, <80 VDC

3.3.1.4 Transmitter Remote Connector

a) This electrical connector **shall**$_{(218)}$ be located on the rear of the MDR transmitter.
b) Signals and levels **shall**$_{(219)}$ be as below:

Transmitter Remote Connector				
Signal	**Level**	**Impedance (Ohms)**	**Input / Output**	**Notes**
Voice Audio	**AS PER SETTING FOR PARAMETER ID#31**	600 ± 60	Input	
TRANSMITTER KEY (CURRENT CONTROLLED)	0 VDC ± 1V (Ground) – Keyed Open - No Key		Input	**10 MA MAX <40 VDC. GROUNDED FOR DURATION OF KEY**
Transmitter Key (Voltage controlled)	+6 VDC to +48 VDC - Keyed Open - No Key		Input	**0.5 MA MAX SINK CURRENT APPLIED FOR DURATION OF KEY**
Transmit Indicator	+5Vdc = Transmitting, 0Vdc = Not radiating, NOTES: 5V TTL Signal		Output	1 Amp max. <80 VDC
Transmit Confirmation	Short-circuit = Transmitting, Open = Not radiating			1 Amp max. <80 VDC

3.3.1.5 Receiver Local Headset Connector

a) The MDR receiver local headset connector **shall**$_{(220)}$ be located on the front panel of the MDR receiver and interface with a type NT49985A or equivalent headset with a PJ055 plug.

Receiver Local Headset Connector	
Pin Number	**Signal**
1 (Ring)	Headset Audio Output
2 (Sleeve)	Headset Audio Return

3.3.1.6 Transmitter Local Microphone Connector

a) The MDR transmitter local microphone connector **shall**$_{(221)}$ be located on the front panel of the MDR transmitter and mate with plug type PJ068 for use with an M85/U carbon microphone, or equivalent.

Transmitter Local Microphone Connector	
Pin Number	**Signal**
1 (Ring)	Microphone Audio Input
2 (Sleeve)	Ground
3 (Tip)	Keyline

3.3.2 MDR Additional Connectors

3.3.2.1 MDT Connector

a) The connector for the MDT **shall**$_{(222)}$ be located on the front panel of the MDR receiver and transmitter.
b) The connector **shall**$_{(223)}$ be a female DB-9, RS-232 serial interface.

3.3.2.2 RIU Connector

a) The MDR receiver and transmitter **shall**$_{(224)}$ each have a single digital data bus interfacing with the RIU.
b) The MDR receiver and transmitter **shall**$_{(529)}$ receive epoch timing from the timing channel and voice/data/signaling communications from the HDLC data channel per NAS-IC-41033502.
c) The connector for the RIU **shall**$_{(225)}$ be located on the rear of the MDR receiver and transmitter.
d) The connector **shall**$_{(226)}$ be a female RJ-48.

Note: The signals for the RIU Connector will be T-1 formatted as defined in the MDR/RIU ICD, NAS-IC-410335022.

3.3.2.3 Reference Frequency Monitor Connector

a) The REF FREQ monitor connector **shall**$_{(653)}$ be located on the front panel of the MDR receiver.
b) The connector **shall**$_{(654)}$ be a female BNC with shielded termination.
c) The termination **shall**$_{(655)}$ be attached to the MDR front panel via a short piece of metal chain.

3.4 Construction Requirements

3.4.1 Physical Requirements

3.4.1.1 Reserved

3.4.1.1.1 Workmanship

a) Workmanship **shall**$_{(239)}$ be in accordance with the requirements of this specification, FAA-G-2100, and MIL-HDBK-454, Guideline 9.

3.4.1.1.2 Equipment Size

a) The MDR receivers and transmitters **shall**$_{(252)}$ be constructed to allow for installation into a standard EIA 19" equipment rack.
b) Mounting hole dimensions, spacing, and panel size **shall**$_{(253)}$ be as specified in EIA-310E (old designation EIA-RS-310D).
c) Each MDR receiver **shall**$_{(254)}$ not exceed 2 units in height and 18.5 inches in depth. (1 unit is equal to 1.75 inches)
d) Each 15 watt MDR transmitter configuration or single enclosure MDR transmitter **shall**$_{(255)}$ not exceed 3 units in height and 18.5 inches in depth.
e) Each 50 watt MDR transmitter configuration **shall**$_{(256)}$ not exceed 4 units in height and 18.5 inches in depth.
f) The MDR shall not protrude greater than 2 inches from the front mounting plane.

NOTE:
1. The front mounting plane is the back (vertical surface) of the MDR front panel, where the MDR front panel meets the front of the rack.
2. Depth is measured from the front mounting plane to the rearmost protrusion.
3. Front protrusion is measured from the front mounting plane to the frontmost protrusion.

3.4.1.1.3 Equipment Weight

a) The individual MDR receiver and transmitter weight **shall**$_{(257)}$ not exceed 37 pounds for each unit in accordance with FAA-G-2100, Section 3.3.6.3, male and female maximum weight lift.

3.4.1.1.4 Equipment Slides

a) The MDR equipment **shall**$_{(258)}$ allow access to control, monitoring and maintenance activities with the equipment bolted to the standard FAA equipment rack.
b) The MDR equipment **shall**$_{(259)}$ include slides that:
    1) extend the MDR equipment the full length of the MDR equipment
    2) have end-stops that prevent over-extension
    3) meet FAA-G-2100, Section 3.1.2.4.3
    4) have the slide component attached to the MDR be separable, without tools, from the slide-component that will be attached to the equipment rack.

3.4.1.1.5 Nameplates

a) Each MDR receiver and transmitter furnished **shall**$_{(260)}$ have a nameplate mounted on the front of the chassis as specified in FAA-G-2100, Section 3.3.3.1 and associated Subsections.

3.4.1.1.6 Pin Layout Identification

a) Numbering or lettering on, or immediately adjacent to, the connectors **shall**$_{(261)}$ identify all connector pins.

3.4.1.1.7 MDR Installation/Removal

a) The MDR receiver and transmitter **shall**$_{(264)}$ be constructed to be installed, removed, and reinstalled with a minimum of common tools and without extensive disassembly.

3.4.1.1.8 MDR Set-Up

a) The MDR receiver and transmitter **shall**$_{(265)}$ be initially set up and adjusted under normal operating conditions (see Section 3.4.3.1), following the procedures in the technical instruction book.

3.4.1.1.9 MDR Warm-up

a) The MDR receiver and transmitter **shall**$_{(266)}$ meet the requirements of full power operation within 30 seconds of turn on.

3.4.1.1.10 Thermal Protection

a) The MDR receiver and transmitter **shall**$_{(267)}$ not be damaged by over-temperature/over-heat conditions.
b) The thermal circuit **shall**$_{(268)}$ not cause a reduction in operation (power output) when operating within the duty cycle and environmental conditions specified.

3.4.1.1.11 Shock and Vibration Protection

a) Shock and vibration protection **shall**$_{(269)}$ conform to MIL-STD-810, Method 516.3, Procedure VI - Bench Handling.
b) In all cases, no fixed part **shall**$_{(270)}$ become loose.
c) No movable part or permanently set adjustment **shall**$_{(271)}$ shift its setting or position.
d) No degradation in MDR receiver and transmitter performance **shall**$_{(272)}$ occur under the environmental service and operational conditions specified herein.

3.4.1.1.12 Grounding, Bonding, and Shielding

a) The MDR receiver and transmitter grounding, bonding, and shielding protection **shall**$_{(273)}$ be as specified in FAA-STD-020B, Sections 3.8, 3.9, and 3.10, and associated Subsections.

3.4.1.1.13 Acoustical Noise Criteria Requirement

a) Reserved
b) Sound pressure and acoustic noise levels generated by the MDR equipment in normal operation **shall**$_{(275)}$ not exceed the limits as specified in FAA-G-2100, Section 3.3.6.1, Subsection c.

3.4.1.1.14 Materials, Processes, and Parts

a) Reserved

b) The components **shall**$_{(278)}$ be equal to or better than those components meeting the applicable EIA standards and suitable for the purpose intended.
c) All parts used in the MDR receiver and transmitter **shall**$_{(279)}$ be operated within their electrical ratings and the environmental requirements of this specification.

3.4.1.1.14.1 Ferrous Materials

a) Ferrous materials, if used, **shall**$_{(280)}$ be corrosion-resisting types.

3.4.1.1.14.2 Reserved

3.4.1.1.14.3 Arc-Resistant Materials

a) Arc-resistant materials **shall**$_{(285)}$ be used for insulation of electrical power circuits where arcing is likely to occur.

3.4.1.1.14.4 Dissimilar Metals

a) Selection and protection of dissimilar metal combinations **shall**$_{(286)}$ be in accordance with FAA-G-2100, Section 3.3.1.1.1 and MIL-STD-889.

3.4.1.1.14.5 Fibrous Material

a) Fibrous material **shall**$_{(287)}$ not be used.

3.4.1.1.14.6 Flammable Materials

a) Flammable materials **shall**$_{(288)}$ not be used without prior FAA approval in accordance with FAA-G-2100, Section 3.3.1.1.3.

3.4.1.1.15 Safety

a) An MDR equipment malfunction **shall**$_{(290)}$ in no way contribute to the destruction of the equipment or any part of its environment.
b) Safety **shall**$_{(291)}$ conform to the requirements of FAA-G-2100, Section 3.3.5 and associated Subsections.
c) Any exposed or accessible area of the MDR equipment that could pose a thermal contact hazard, as defined in the FAA Human Factors Guide, section 12.10.1, **shall**$_{(676)}$ be clearly labeled as a Thermal Contact Hazard.

3.4.1.1.16 Human Performance/Human Engineering

a) The MDR receiver and transmitter **shall**$_{(292)}$ conform to the applicable criteria contained in FAA-G-2100, Section 3.3.6 and the FAA Human Factors Design Guide.

3.4.1.1.17 Removable Parts and Mating Connectors

a) Reserved

b) When two or more pieces of equipment require interconnection, the necessary mating connectors (except coaxial) **shall**$_{(295)}$ be supplied for both the MDR and associated equipment that interfaces with the MDR in accordance with FAA-G-2100, Section 3.1.2.1.

3.4.1.2 Controls

3.4.1.2.1 Frequency Change Time

a) The time required to completely retune the MDR receiver or transmitter to a new frequency, including any required realignment **shall**$_{(297)}$ not exceed 30 minutes including retuning of the internal filters.
b) MDR receivers and transmitters **shall**$_{(298)}$ include protective features to guard against inadvertent frequency changes.

3.4.1.2.2 Detents

a) The controls with an "OFF" position **shall**$_{(299)}$ have a detent or equivalent in the ON position to prevent inadvertent operation.

3.4.1.2.3 Adjustment Range

a) The adjustment range of the MDR receiver and transmitter operation and maintenance controls **shall**$_{(300)}$ be constructed to preclude damage to the equipment or its subassemblies when adjusted to the limits of the control travel.
b) The range of control **shall**$_{(301)}$ be constructed to reduce the sensitivity and criticality of the adjustment task to the maximum extent possible.

3.4.1.2.4 Power Switches/Power On Indicators

a) The MDR receiver and transmitter **shall**$_{(302)}$ have front panel mounted AC and DC power switches and a Primary Power Source Selector switch next to or in between these power switches.
b) An AC Power On indicator **shall**$_{(657)}$ be located adjacent to the AC Power switch, and be lit when AC Power is applied to the MDR and the AC Power Switch is in the On position.
c) A DC Power On indicator **shall**$_{(658)}$ be located adjacent to the DC Power switch, and be lit when DC Power is applied to the MDR and the DC Power Switch is in the On position.
d) The MDR **shall**$_{(686)}$ provide visual indication of which power source, AC or DC, is selected as primary.
e) Power switches **shall**$_{(305)}$ be protected from inadvertent action (operation).

3.4.1.2.5 Front Panel Display

a) The MDR receiver and transmitter front panel **shall**$_{(306)}$ provide

1) an alphanumeric display of the frequency, mode of operation, and operational state
2) three separate visual indicators (e.g., LEDs) for quick-look status

b) The MDR receiver and transmitter visual indicators **shall**$_{(530)}$ provide visual indications on the front panel as follows:
   1) A red indicator that is lit in the event of a failure or when the MDR is in Failed state.
   2) A yellow indicator that is lit in the event of an alert, and flashes in the event of an alarm.
   3) A green indicator that is lit when the MDR is in Offline or Online state, and flashes when the MDR is in Recovery state.

c) The visual indications for failure events, alarm events and alert events **shall**$_{(531)}$ remain until the failure, alarm or alert is cleared by the respective Return to Normal.

d) The MDR transmitters' front panel **shall**$_{(671)}$ have an additional blue visual indicator, physically separate from the other visual indicators, that indicates PTT keying while in DSB-AM mode.

e) The front panel alphanumeric display **shall**$_{(307)}$ be back-lit, and viewable for at least ± 30 degrees off horizontal or vertical axis.

f) The visual indicators **shall**$_{(672)}$ be viewable for at least +/- 60 degrees off horizontal or vertical axis and be clearly visible from 10 feet away in a brightly lit room.

3.4.1.2.6 Functions and Labeling

a) Labeling **shall**$_{(309)}$ be permanent, legible, and mounted so that the data are visible to personnel without the need to disassemble the part or adjacent functional or structural parts.

b) Connectors **shall**$_{(310)}$ be identified on the plug-in side by labels that describe their specific functions.

c) All fuse positions **shall**$_{(311)}$ be marked with the rated current capacity, voltage rating, and type of fuse to be used.

d) Delayed action fuses **shall**$_{(312)}$ have the additional designation "SLOW".

e) All fuse markings **shall**$_{(313)}$ be on the insertion side, so as to be visible when replacing fuses.

f) The following functions and corresponding labels **shall**$_{(314)}$ be available on the MDR receiver and transmitter as specified in Table 3-5:

Table 3-5: MDR Functions and Labeling

Functions	Labeling
AC Power ON/OFF Switch (Rx & Tx)	AC PWR ON/OFF
DC Power ON/OFF Switch (Rx & Tx)	DC PWR ON/OFF
AC Power ON Indication Light (Rx & Tx)	AC PWR
DC Power ON Indication Light (Rx & Tx)	DC PWR
Primary Power Source (Rx & Tx)	PRIMARY PWR: AC/DC
Failure Indication Light (Rx & Tx)	FAIL
Alarm/Alert Indication Light (Rx & Tx)	**ALERT (solid)/ ALARM (flashing)**
Online/Offline/Recovery Indication Light (Rx & Tx)	ONLINE/OFFLINE (solid) / RECOVER (flashing)

PTT / Transmit Indication Light (Tx only)	TRANSMIT
Transmitter Local Microphone Connector (Tx only)	MIC
Receiver Local Headset Connector (Rx only)	HEADSET
AC Fuse Holder/Circuit Breaker AMP (TBS) (Rx & Tx)	120 VAC/ (TBS) Amps (Slow*)
DC Fuse Holder/Circuit Breaker AMP (TBS) (Rx & Tx)	24 VDC/ (TBS) Amps (Slow*)
Local Volume Control (Rx)	Volume Control
AC Input Power Connector (Rx & Tx)	120 VAC/60 Hz
DC Input Power Connector (Rx & Tx)	24 VDC
MDR Antenna RF Out Connector (Rx & Tx) *	MDR RF

Table 3-5: MDR Functions and Labeling (continued)

Functions	Labeling
Internal Filter Input Connector (Rx & Tx) *	FILTER IN
Internal Filter Output Connector (Rx & Tx) *	FILTER OUT
Antenna Transfer Relay (Common) Connector (Tx only) *	ATRC
Antenna Transfer Relay Connector #1 (Tx only) *	ATR1
Antenna Transfer Relay Connector #2 (Tx only) *	ATR2
MDT Connector (Rx & Tx)	MDT
RIU Connector (Rx & Tx)	RIU
Remote Connector (Rx & Tx)	RCE
Reference Frequency Monitoring (RX)	REF FREQ Monitor
Access to Internal Filter for Tuning (Rx & Tx)	FILTER TUNING

* If applicable.

3.4.1.2.7 Filter Tuning

a) If the internal filter is manually tunable, it **shall**$_{(386)}$ be tunable via the front panel.
b) The MDR transmitter **shall**$_{(656)}$ be tunable within the spectral mask requirements specified in Section 3.2.2.2.10a and 3.2.2.2.10b, without the use of an external signal generator.

Note: The MDR transmitter may employ a special very-low power mode to allow filter tuning without tripping self-protection functions.

3.4.1.3 MDR Identification (ID) Numbering

a) Each MDR **shall**$_{(681)}$ have a permanent, non-changeable and unique identification (ID) number which is both marked on the front panel and accessible via the Monitoring Parameter ID#50, MDR ID number.
b) MDR ID numbers **shall**$_{(682)}$ be assigned so that Transmitter ID numbers are odd numerically and Receiver ID numbers are even numerically.
c) MDR ID numbers **shall**$_{(683)}$ be as specified in Section 3.2.3.5.30.

3.4.2 Electrical Requirements

3.4.2.1 Input Power Requirements

a) The MDR equipment **shall**$_{(316)}$ meet the requirements of this specification with primary line input voltage of 120 VAC (±10 percent), 60 Hz (±3 Hz) single phase and with an alternate line input voltage of 24 VDC, negative ground, (-10/+20 percent).
b) During the loss of primary power (or non-availability of primary power) the equipment **shall**$_{(317)}$ automatically switch to operating off secondary power.
c) Activation of this internal automatic line switchover **shall**$_{(318)}$ allow for equipment operation from a secondary DC power source.
d) The MDR equipment **shall**$_{(319)}$ operate under varying conditions, such as slow variations of AC and DC line voltages and AC line frequency, within the ranges specified herein.
e) The MDR equipment **shall**$_{(320)}$ automatically resume normal operation when subjected to power interruptions and/or outages in accordance with FAA-G-2100, Section 3.1.1.8.
f) Both AC and DC voltage inputs **shall**$_{(321)}$ be from the rear of the MDR equipment, and when practical, be located on the lower right side of the MDR equipment as viewed from the rear.
g) The maximum current limits for the MDR equipment **shall**$_{(322)}$ be as listed in Table 3-6.
h) If both AC and DC power are available to the MDR, the MDR **shall**$_{(700)}$ operate off of the power source selected by the Primary Power Source Switch.
i) Automatic switching between power sources in the event of power loss of one power source **shall**$_{(684)}$ occur regardless of the primary power source selection.
j) Manual or automatic switching between power sources **shall**$_{(685)}$ not interrupt MDR operation nor degrade MDR performance.

Table 3-6: Maximum Current Limits

Component	AC Current (AMPERES)	DC Current (AMPERES)
MDR Receiver	1.0	3.0
MDR Transmitter (15 Watt RF Output Maximum)	4.0	10.0
MDR Transmitter (50 Watt RF Output Maximum)	8.0	20.0
Single Enclosure MDR Transmitter (Set at or below 15 Watts)	4.0	10.0
Single Enclosure MDR Transmitter (Set above 15 watts)	8.0	20.0

Note: The actual average current values will be supplied by the vendor.

3.4.2.1.1 Power Cords

a) The equipment **shall**$_{(323)}$ be provided with: 1) a removable six-foot, three-conductor AC power cord, and 2) a removable six-foot, two-conductor DC power cord, each matching with the respective connector on the MDR receiver and transmitter.
b) The AC cord(s) **shall**$_{(324)}$ have the AC protection ground lead configured to ground the chassis as specified in FAA-G-2100, Section 3.1.1.9.

3.4.2.2 Reverse Polarity Protection

a) The MDR receiver and transmitter **shall**$_{(325)}$ incorporate reverse polarity protection to prevent damage to the MDR equipment if the polarity of the 24 VDC input voltage is reversed.

3.4.2.3 Circuit Protection

a) All MDR receiver and transmitter input/output circuits **shall**$_{(326)}$ include circuit protection which prevents opens or shorts at the input/output terminals from damaging the equipment.
b) When the short or open is removed, circuit performance **shall**$_{(327)}$ show no sign of performance degradation in accordance with FAA-G-2100, Section 3.1.1.7.

3.4.2.3.1 Current Overload Protection

a) Current overload protection for the MDR receiver and transmitter **shall**$_{(328)}$ be provided by fuses, circuit breakers, or other protective devices for primary input AC and DC circuits as specified in FAA-G-2100, Section 3.3.1.3.2 and associated Subsection.

3.4.2.3.2 Protective Caps

a) Protective caps for mating with normally unmated or infrequently used connectors (i.e., local microphone input jacks or test/diagnostic input/output connectors) on the MDR receiver and transmitter **shall**$_{(329)}$ be provided in accordance with FAA-G-2100, Section 3.3.1.3.3.4.

3.4.2.3.3 Electrostatic Discharge Control

a) Reserved
b) All circuits and components used in the MDR equipment that are susceptible to damage by ESD **shall**$_{(331)}$ be protected as specified in FAA-G-2100, Section 3.2.7 and FAA-STD-020B, Section 3.12.3.

3.4.2.3.4 AC Harmonic Content

a) The total harmonic content of the MDR receiver or transmitters current **shall**$_{(332)}$ not produce a total harmonic distortion (THD) that exceeds 5 percent of the fundamental (AC at 60 Hz) source current. See IEEE/ANSI Std 519-1992.
b) No single harmonic **shall**$_{(333)}$ be greater than 3 percent of the fundamental (AC at 60 Hz) source power current.

3.4.2.3.5 AC Inrush Current Limiting

a) The MDR receiver and transmitter AC inrush current characteristics (in all of the equipment configurations) **shall**$_{(334)}$ not exceed 1.5 times overcurrent shown in Figure 3-3.
b) The duration of the inrush current **shall**$_{(335)}$ be measured from the point at which the power is turned on to the point to which the current returns within 110 percent of its normal value. See FAA-G-2100, Section 3.1.1.2.2.

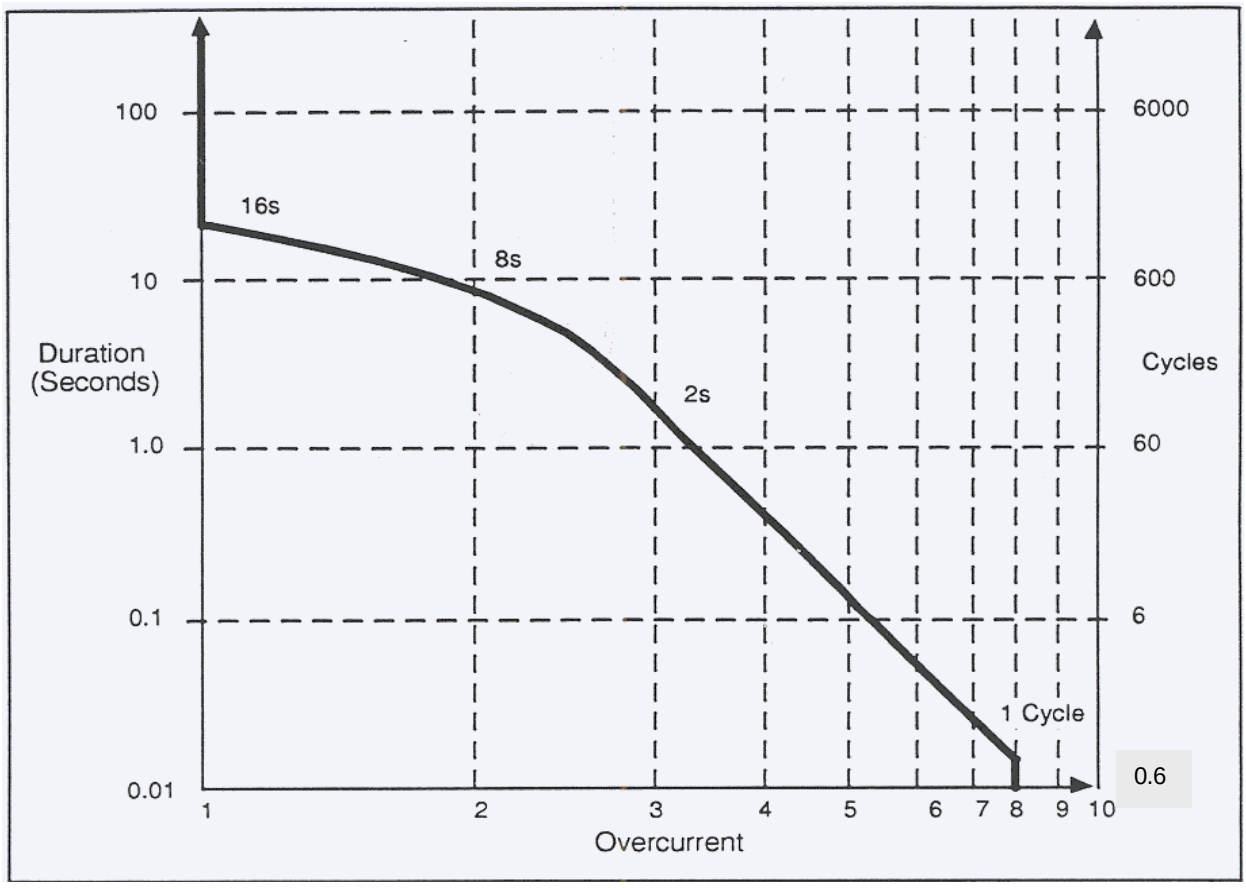


Figure 3-3: Inrush Current Limiting Requirements

3.4.2.3.6 AC Power Factor

a) The MDR receiver and transmitter (in all of their configurations) **shall**$_{(336)}$ present a power factor to the AC power source of not less than 0.7 leading or lagging when operating under steady state conditions, from 25 percent to 100 percent of full load at the nominal line voltage (120VAC). See FAA-G-2100, Section 3.1.1.2.1.

3.4.2.3.7 Transient Protection

a) The MDR receiver and transmitter **shall**$_{(337)}$ contain protective devices in the audio circuits that conform to IEEE/ANSI Standards C62.36-1994, (Surge Protectors Used in Low-voltage Data, Communications, and Signaling Circuits), in the RF circuits that conform to IEEE/ANSI Standards

C62.31-1987, (Gas-Tube Surge-Protective Devices), and in the AC power circuits that conform to IEEE/ANSI Standards C62.41-1991, (IEEE Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits).

b) The MDR receiver and transmitter **shall**$_{(338)}$ provide overall unit protection as outlined in IEEE/ANSI Standard C62.47-1992, (IEEE Guide on Electrostatic Discharge (ESD)).

3.4.2.4 Test Points

a) External test points **shall**$_{(340)}$ be female BNC type connectors.

3.4.2.5 Reserved

3.4.2.6 Loss of Input Voltage

a) The loss or variance of input voltage, including loss of voltage caused by activation of circuit protector devices, **shall**$_{(344)}$ not cause or induce any damage to any component in the MDR receiver and transmitter or other interfacing equipment.

3.4.3 Environmental Conditions

a) The MDR receiver and transmitter **shall**$_{(345)}$ be constructed of materials to withstand any combination of environmental and service conditions specified below without causing damage or degradation of performance below the requirements of this specification.

3.4.3.1 Operating Conditions

a) The MDR receiver and transmitter **shall**$_{(346)}$ be able to operate in a facility under the operating conditions specified in Table 3-7:

Table 3-7: Operating Conditions

Temperature Range	-10° C to +50° C
Relative Humidity	5 to 90 percent (above 40 °C, the relative humidity is based on the dew point of 40°C)
Altitude	0 to 15,000 Feet

3.4.3.2 Non-Operating Conditions

a) Non-operating conditions for the MDR receiver and transmitter are those conditions affecting equipment in storage, in shipment, in the process of being installed at a site, and installed at a site but non-operating. The MDR equipment **shall**$_{(347)}$ meet the requirements for a non-operating conditions in Table 3-8:

Table 3-8: Non-Operating Conditions

Temperature Range	-40° C to +70° C

Relative Humidity	up to 100 percent including condensation due to temperature changes
Altitude	0 to 50,000 Feet

3.4.3.3 Equipment Ventilation and Cooling

a) Reserved
b) Reserved
c) The MDR front panel **shall**$_{(351)}$ not present a thermal contact hazard to personnel in accordance with FAA Human Factors Guide, Section 12.10.1.

3.4.4 Electromagnetic Compatibility Requirements

a) Reserved
b) Electromagnetic emission and susceptibility of the MDR receiver and transmitter **shall**$_{(352)}$ not exceed the limits in MIL-STD-461 requirements CE-102, CS-101, CS-114, CS-115, CS-116, RE-102 and RS-103. Where conflict exists between "Navy Procurement", "Air Force Procurement", and "Army Procurement", the "Army Procurement" takes precedence.

3.5 Quality Factors

3.5.1 Reliability

3.5.1.1 Mean Time Between Failures

a) The predicted Mean Time Between Failures (MTBF) for the MDR (receiver and transmitter) **shall**$_{(353)}$ be not less than 26,280 hours.

3.5.2 Maintainability

a) The MDR receiver and transmitter **shall**$_{(354)}$ provide parameter adjustments for routine maintenance.
b) The MDR receiver and transmitter each **shall**$_{(355)}$ be an LRU.

3.5.2.1 Mean Time To Repair

a) The Mean Time To Repair (MTTR) of the MDR (receiver and transmitter) **shall**$_{(357)}$ not be greater than 30 minutes at the site (LRU Replacement).

3.5.2.2 Periodic Maintenance

a) The MDR receiver and transmitter **shall**$_{(363)}$ be configured so that periodic maintenance can be performed without disrupting other MDRs that are on-line.
b) Periodic maintenance intervals **shall**$_{(364)}$ meet or exceed one year.

3.5.3 Service Life

a) The MDR receiver and transmitter **shall**$_{(365)}$ have a minimum useful service life of 20 years.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility For Inspection

Not applicable

4.2 Special Tests And Examinations

Not Applicable

4.3 Requirement Cross Reference

The Contractor Verification Requirement Traceability Matrix provides a mapping of FAA-E-2938 requirement "shalls".

4.4 Qualification Test Requirements

4.4.1 Test Planning/Procedures

The test and evaluation process will be used to ensure that the contractor has met and implemented the requirements of the FAA-E-2938. The contractor will perform the requirement verification in accordance with the contract SOW.

4.4.2 Test Phases and Levels

The NEXCOM MDR test efforts will consist of five distinct test phases:

a) Contractor – conducted Factory Acceptance Test (FAT)
b) Contractor – conducted Production Acceptance Test (PAT)
c) Contractor – conducted Site Acceptance Test (SAT) (includes KEYSITE ACCEPTANCE TEST & SITE ACCEPTANCE TEST)
d) Government – conducted Operational Test (OT)
e) Government – conducted Independent Operational Test & Evaluation (IOT&E)

4.4.2.1 Factory Acceptance Test Phase

Factory Acceptance Test (FAT) is a contractor – conducted test comprising full NEXCOM MDR configured items. FAT will be conducted at the contractor's facility. All FAT testing will be conducted according to Government – approved test plans, test procedures, and test reports. FAT will be conducted by the contractor and witnessed by an authorized Government representative(s). FAT testing will be the basis for determining compliance of all physical, functional and performance system dependent requirements contained in FAA-E-2938.

4.4.2.2 Production Acceptance Test Phase

Production Acceptance Test (PAT) is a contractor – conducted test. PAT will be conducted at the contractor's facility. All PAT testing will be conducted according to Government – approved test plans, test procedures, and test reports. PAT will be conducted by the contractor and witnessed by an

authorized Government representative(s). PAT testing will be the basis for determining compliance to all applicable specifications, is free from manufacturing defects, and is identical to the qualified hardware.

4.4.2.3 Site Acceptance Test Phase

Site Acceptance Test (SAT) is a contractor – conducted test. SAT will be conducted at the FAA Key Site(s) and at each site where the contractor performs the installation of a Multi-Digital Radio (MDR). All SAT testing will be conducted according to Government - approved test plans, test procedures, and test reports. SAT will be conducted by the contractor and witnessed by an authorized Government representative(s). SAT testing will be the basis for determining compliance of the MDR at each site. SAT testing will address site unique configuration and capabilities.

4.4.2.4 Operational Test

Operational Test (OT) is a Government – conducted test. It will be conducted at the William J. Hughes Technical Center (WJHTC), Atlantic City, NJ. OT will evaluate the degree to which the MDR product accomplishes its mission when used by representative personnel in the expected operational environment. Effectiveness and suitability testing and evaluation may be continued at the Key Site(s) if a complete assessment cannot be accomplished at the WJHTC. There are a number of prerequisites to the conduct of OT which may include: successful completion of FAT, an MDR configured baseline, approved technical documentation and completion of System Test and Evaluation training for Government representative(s).

4.4.2.5 Independent Operational Test and Evaluation (IOT&E)

Independent Operational Test and Evaluation (IOT&E) is a Government – conducted test. IOT&E is a full system level evaluation conducted in a realistic operational environment to confirm the operational readiness of the MDR system to be part of the NAS.

4.5 Qualification/Verification Methods

The NEXCOM MDR will undergo test and evaluation to verify that the MDR meets specification requirements. The verification methods noted below will be mandatory for NEXCOM MDR requirement verification.

4.5.1 Inspection

Inspection of NEXCOM Radio will include verifying physical characteristics to determine compliance with requirements without the use of special laboratory equipment, procedures, items or services. Inspection will verify workmanship, physical condition, construction features, and document/drawing compliance. All tests are non-destructive, static – state examinations of the hardware, the technical data and documentation.

4.5.2 Test

The NEXCOM MDR testing will measure hardware performance during or after the controlled application of functional stimuli. Measurements require the use of laboratory equipment, procedures, items, and/or services. Quantitative measurements are analyzed to determine the degree of compliance.

4.5.3 Demonstration

Demonstration verification method is used to indicate a general "pass/fail" condition. The items being verified are observed but not quantitatively measured in a dynamic state. This method may use technical data and documentation to determine the qualitative properties of the item being tested. This method does not require special test equipment or instruction to vary characteristics such as operational performance, human engineering features, and service, access features, or transportability.

4.5.4 Analysis

The NEXCOM MDR analysis will encompass any or all of the following:

a) Engineering analysis is usually an engineering design function involving study, calculations, or modeling of the known or potential failure modes, and reaction or interactions of the specified parts, materials, and the design configuration with the known function, performance and/or probable effects of the operational environments. This analysis is normally used to verify margin when it is not desirable to test to failure.
b) Similarity analysis is a method applied to end items or components that are identical in design and manufacturing processes to end items or components that have been previously qualified to equivalent or more stringent requirements.
c) Validation of records analysis is a method of verification wherein manufacturing records are used to verify compliance of concealed construction features or processes of manufacturing (e.g. vendor items).

4.6 Reserved

4.7 Tests

4.7.1 Electromagnetic Compatibility Tests

a) The MDR equipment EMC compatibility will be carried out in accordance with the conditions specified in Section 3.4.4.

4.8 Verification Methods

a) Verification methods will be utilized in measuring equipment performance and compliance of individual requirements contained in this specification. The four verification methods, TEST, DEMONSTRATION, ANALYSIS, and INSPECTION, listed in decreasing order of complexity, are described as follows:
   1) TEST. Test is a method of verification wherein performance is measured during or after the controlled application of functional and/or environmental stimuli. Quantitative measurements are

analyzed to determine the degree of compliance. The process uses laboratory equipment, procedures, items, and services.

2) DEMONSTRATION. Demonstration is a method of verification where qualitative determination of properties is made for an end item, including the use of technical data and documentation. The items being verified are observed, but not quantitatively measured, in a dynamic state.
3) ANALYSIS. Analysis is a method of verification that consists of comparing hardware design with known scientific and technical principles, procedures and practices to estimate the capability of the proposed design to meet the mission and system requirements.
4) INSPECTION. Inspection is a method of verification to determine compliance without the use of special laboratory appliances, procedures, or services, and consists of a non-destructive static-state examination of the hardware, the technical data and documentation.

5.0 PREPARATION FOR DELIVERY

a) The MDR receiver and transmitter will be delivered in accordance with Section F of the contract.

6.0 NOTES

6.1 Notes on Information Items

The contents of this Section are for informational purposes only and are not a part of the requirements of this specification. They are not contract requirements nor binding on either the Government or the Contractor. In order for these terms to become a part of the resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the Contractor on the information in these Subsections is wholly at the Contractor's own risk.

6.2 Applicable Definitions

6.2.1 Very High Frequency (VHF)

In this document the term VHF applies specifically to the frequency range 112.000 MHz – 137.000 MHz, the frequency range reserved for Aeronautical Mobile (Route) Service.

6.2.2 Ultra High Frequency (UHF)

In this document the term UHF applies specifically to the frequency range 225.000 MHz -399.975 MHz, the frequency range reserved for military navigation and communications.

6.2.3 Mean Time Between Failures (MTBF)

A basic measure of reliability for LRUs is the sum of the operating time for the failed LRUs divided by the number of failures.

6.2.4 Mean Time To Repair (MTTR)

A basic measure of maintainability: the sum of corrective maintenance times at any specific level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions.

6.2.5 Mean Time To Repair Maximum

The maximum time taken to repair a unit, at a depot level work station, to return it to an operational state.

6.2.6 Duty Cycle

Duty cycle is defined as the percentage of time that the transmitter is keyed in proportion to total service time.

6.2.7 Modular Construction

Equipment constructed so all subassemblies are modules that plug into the main chassis.

6.2.8 Line Replaceable Unit (LRU)

An item which may consist of a unit, an assembly (circuit card assembly, electronic component assembly, etc.), a subassembly, or a part, that is removed and replaced at the site maintenance level in order to restore the system/equipment to operational status.

6.2.9 Co-channel Interference

The power ratio of the wanted signal level to the unwanted signal level at the specified voice quality is the co-channel interference protection in dB (positive value). The co-channel interference protection for VDL Mode 3 data /digitized voice is the overall capability of a receiver to demodulate a signal properly (to achieve a defined BER performance) in the presence of an unwanted modulated signal at the same assigned frequency. The co-channel interference protection for DSB-AM voice is the overall capability of the receiver to provide intelligible voice in the presence of an unwanted modulated signal at the same assigned frequency. The co-channel interference requirement has a major impact on frequency re-use planning criteria.

6.2.10 Adjacent Channel Emissions

Adjacent channel emissions are interference signals resulting from modulated RF signal power transmitted that are outside of the assigned channel. Adjacent channel emissions include discrete frequency spurious signals, and noise like signals (including phase noise) at the transmitter output.

6.2.11 Bit Error Rate

The BER corresponds to the uncorrected bit error probability and is expressed as the ratio of the number of incorrect bits received to the total number of bits received without benefits of Forward Error Correction (FEC).

6.2.12 Definitions for Fixed and Remotely Tunable Configurations and ATR Function

6.2.12.1 Fixed Tuned Configuration

The MDR receiver and transmitter configurations are similar to the present day radios in the NAS. The MDR receiver and transmitter will contain a fixed tuned internal cavity filter that is tunable by the system specialist with common hand tools. In addition, the MDR transmitter will also contain a transfer relay that allows multiple MDRs to be connected to a single antenna. This is illustrated in Figure 6-1. This configuration will differ from its present implementation in that the filter can be by-passed. The system specialist will have the option of using the internal fixed tuned filter or using the radio without the filter present.

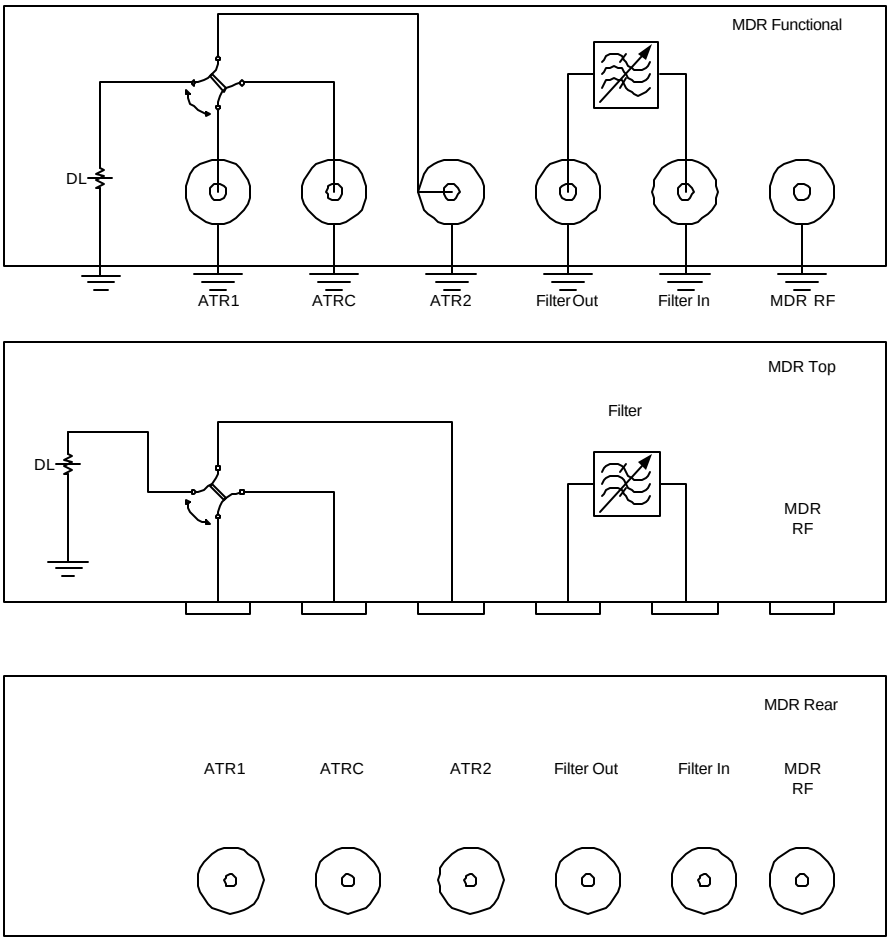


Figure 6-1: Conceptual Illustration of Internal Filter/Antenna Transfer Relay Configuration

6.2.12.2 Remotely Tunable Configuration

This MDR configuration allows the radio to be tuned via the MDT connector on the radio as well as remotely via the RIU interface. The only equipment required to facilitate a frequency change will be an MDT used either locally or remotely via the RIU.

6.2.13 Initialization

Initialization (also cold start) occurs when (a) the MDR receiver or transmitter is first turned on when delivered from the factory, and (b) when the MDR receives the Reset command with Value of Factory Reset. A result of initialization is that all control parameters return to their default values.

6.2.14 Restoral

Restoral (also warm start) occurs when the power is returned to the MDR receiver or transmitter under all conditions other than initialization. As a result of restoral function all configuration parameters are

automatically restored to the values that were in effect in the operational state before the restoral stimulus occurs.

6.2.15 MDR State Definitions

OFF	MDR does not receive either AC or DC power sufficient for MDR operation
POWER UP	The state the MDR is in during the time between power restoral, power turn on or Operator commanded Reset, and the MDR a) entering Online or Offline, or b) entering Failed state after detecting a non-recoverable failure, or c) entering Failed state after detecting that the MDR was in Failed state immediately prior to most recent power down or power loss or d) entering Recovery state after detecting a potentially recoverable failur. The MDR will conduct initial self testing (e.g BIT or POST) during the Power Up state.
OFFLINE	An operational state in which the remote user's (controller's) ability to use the MDR is disabled, but the MDR is otherwise fully operational. The MDR will conduct background built-in testing to verify MDR health.
RECOVERY	A non-operational state entered after the MDR detects a potentially recoverable error, in which only certain monitor and control functions are enabled.
ONLINE	The operational state in which the MDR meets all operational requirements and all functions are enabled except local audio and PTT input and most control commands. The MDR will conduct background built-in testing to verify MDR health.
FAILED	The non-operational state the MDR enters after a non-recoverable failure has been detected, or the Recovery process has failed. During Failed state, only those monitor and control functions that can be performed accurately, despite the failure are enabled.
POWER DOWN	The state the MDR enters after an Operator-commanded Shutdown, but before the power is removed. All MDR functions, except those required to complete the Power Down process, are disabled. *Note: This is an optional state that a vendor's implementation may require. If the vendor's implementation includes a power down sequence other than removing power (i.e. that takes any time), the Power Down state requirements apply.*

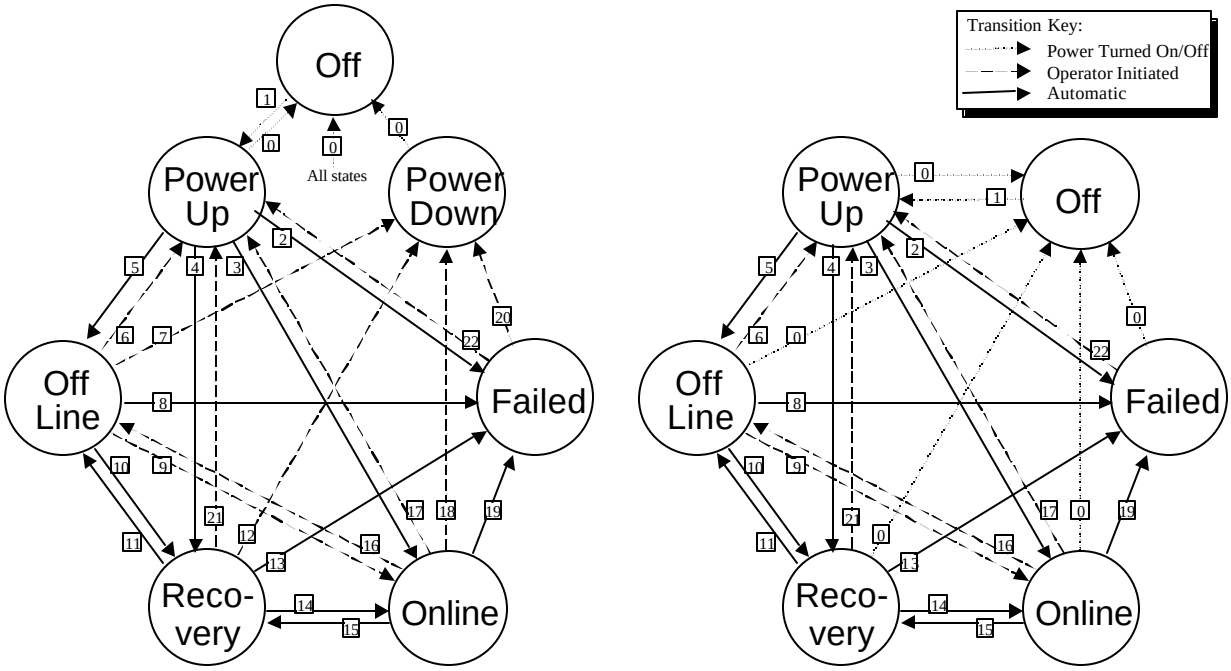


Figure 6-2: MDR State Diagram

Table 6-1: State Transition Table

Transition	From State	To State	Auto/Manual	Description (Condition for Transition)
0	Any	Off	M/(A)	Whenever power is turned off (or lost)
1	Off	Power Up	M/(A)	Whenever power is turned on (or restored)
2	Power Up	Failed	A	When Power Up sequence fails OR Failed State entered before last Power Down/Off
3	Power Up	Online	A	a) Successful completion of Power Up sequence and b) State before Power Down/Off was Online
4	Power Up	Recovery	A	Power Up sequence completed but recoverable error detected
5	Power Up	Offline	A	a) Successful completion of Power Up sequence and b) State before Power Down/Off was Offline
6	Offline	Power Up	M	Operator commanded Reset
7	Offline	Power Down	M	Local Operator initiates power-down

Table 6-1: State Transition Table (continued)

Transition	From State	To State	Auto/Manual	Description (Condition for Transition)
8	Offline	Failed	A	MDR detects unrecoverable error (e.g., POST, BIT, etc.)
9	Offline	Online	M	Operator commands Online mode
10	Offline	Recovery	A	Potentially recoverable error detected while Offline
11	Recovery	Offline	A	a) Recovery sequence successful and b) Previous state was Offline
12	Recovery	Power Down	M	Local Operator initiates power down
13	Recovery	Failed	A	Recovery sequence unsuccessful
14	Recovery	Online	A	a) Recovery sequence successful and b) Previous state was Online
21	Recovery	Power Up	M	Operator commanded Reset
15	Online	Recovery	A	Potentially recoverable error detected while Online
16	Online	Offline	M	Operator commands Offline
17	Online	Power Up	M	Operator commanded Reset
18	Online	Power Down	M	Local Operator initiates power-down
19	Online	Failed	A	MDR detects unrecoverable error (e.g., POST, BIT, etc.)
20	Failed	Power Down	M	Local Operator initiates power-down
22	Failed	Power Up	M	Operator commanded Reset

6.2.16 Non-Volatile Memory

The MDR memory storage that will retain data for the life of the equipment.

6.2.17 Equipment Failures

Equipment failure is classified into non-critical failure and critical failure.

6.2.17.1 Non-critical Equipment Failure

Non-critical equipment failures are failures of the MDR that will not affect the operations of the MDR, e.g., front panel display and power indicator failures.

6.2.17.2 Critical Equipment Failure

Critical equipment failures are failures of the MDR that will either disrupt the operational traffic flow or that will result in loss of capabilities and functions required for continued safe operation of the MDR. Examples of the former include failure to the power amplifier in the transmitter, failure to the RF front

end in the receiver, and failure to the power supply subsystem of the MDR. Examples of the latter include failures of the control or monitoring capabilities in the MMC system.

6.2.18 MDR RF Output

The transmitter connector to which the antenna would be connected in a particular configuration.

6.2.19 MDR RF Input

The receiver connector to which the antenna would be connected in a particular configuration.

6.3 Configuration of Chaining Multiple MDRs to a Common Antenna Using the ATR

The MDR needs a capability to connect multiple MDR units to a single antenna. The series of figures that follow illustrate the various cases of connections prevalent in the FAA installations that the MDR is expected to handle internally.

The abbreviations used in the figures (see also Figure 6-1) mean the following:

ATR1 Connection to ATR connector 1
ATR2 Connection to ATR connector 2
ATRC Connection to the ATR common connector
CF1 Input connection to the internal filter
CF2 Output connection from the internal filter

Figure 6-3 shows the transceiver configuration, i.e., transmitter and receiver sharing an antenna. The figure illustrates three cases, first without filters, the second with the use of internal filters, the third the use of external filters.

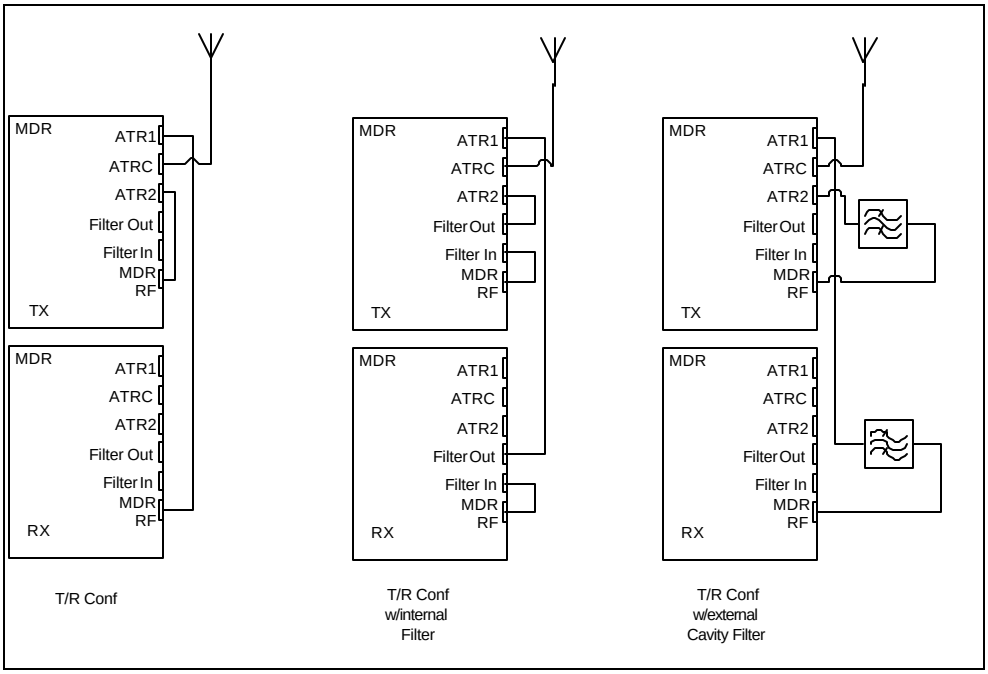


Figure 6-3: Conceptual Illustration of Transceiver Configuration

Figure 6-4 shows the configuration of a main and standby transmitter sharing an antenna. The three cases indicated in the previous paragraph are also shown for this configuration.

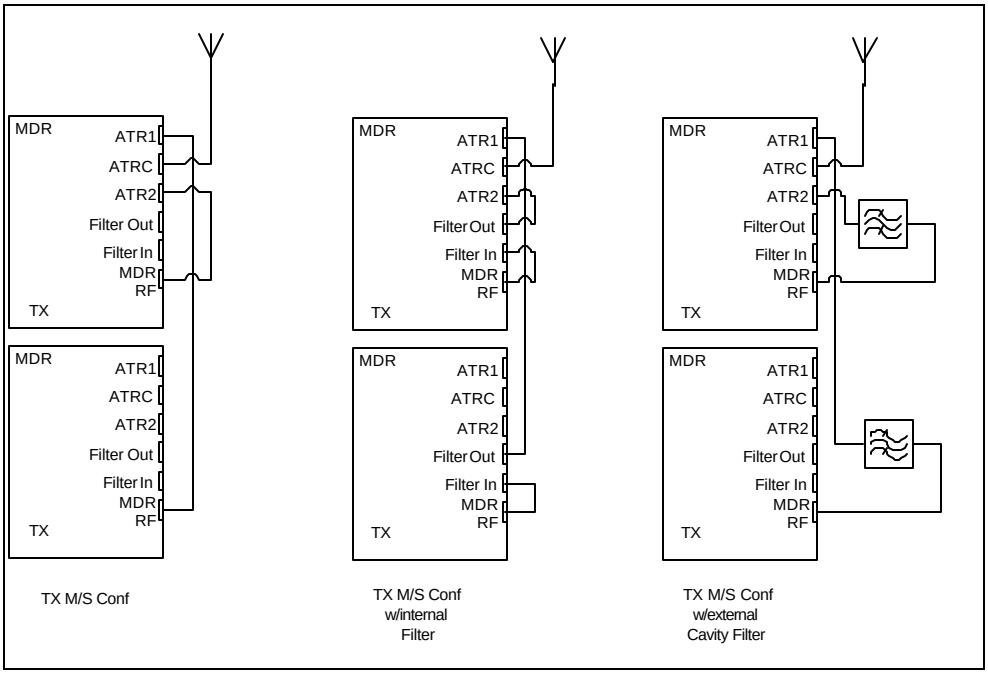


Figure 6-4: Conceptual Illustration of Transmitter Main/Standby Configuration

APPENDIX A

List of Acronyms

A/G	Air-Ground
ACK	Acknowledgment
AF	Airway Facilities
AGC	Automatic Gain Control
AM	Amplitude Modulation
AM(R)S	Aeronautical Mobile (Route) Services
ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials
ATC	Air Traffic Control
ATN	Aeronautical Telecommunications Network
ATR	Antenna Transfer Relay
ATRC	Antenna Transfer Relay Center Connection
BER	Bit Error Rate
BIT	Built in Test
C	Centigrade
CF	Connection to Filter
CRC	Cyclic Redundancy Check
CW	Continuous Wave
D-burst	Data Burst
D8PSK	Differential 8 Phase Shift Keying
dB	Decibel
dBc	Decibels referenced to carrier
dBm	Decibels referenced to 1 milliwatt
DLS	Data Link Service
DSB-AM	Double Side-Band Amplitude Modulation
DSRCE	Down Scoped Radio Control Equipment
EMC	Electromagnetic Compatibility
EIA	Electronic Industries Alliance
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FAA	Federal Aviation Administration
FEC	Forward Error Correction
FIR	Finite Duration Impedance Response (filter)
FM	Frequency Modulation
GME	Global Management Entity
GNI	Ground Network Interface
GNSS	Global Navigation Satellite System
Hz	Hertz
HD	Header

HDLC	High Level Data Link Control
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Standards Organization
kHz	kilohertz
LBAC	Logical Burst Access Channel
LED	Light Emitting Diodes
LEN	Length
LME	Local Management Entity
LRU	Line Replaceable Unit
M-burst	Management Burst
mA	Milliampere
MAC	Media Access Control
MASPS	Minimum Aviation System Performance Standards
MDR	Multimode Digital Radio
MDT	Maintenance Data Terminal
MHz	Megahertz
MS	Milliseconds
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
N/A	Not Applicable
NAS	National Airspace System
NEMA	National Electrical Manufacturers Association
NEXCOM	Next Generation Air/Ground Communications System
NGW	Number of Golay Words
NIMS	NAS Infrastructure Management System
NTIA	National Telecommunications and Information Administration
OEM	Original Equipment Manufacturer
OSI	Open System Interconnection
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
ppm	Parts Per Million
POST	Power-up Operational Self Test
PTT	Push-to-Talk
RAM	Random Access Memory
RCAG	Remote Center Air/Ground
RCE	Radio Control Equipment
RCO	Remote Communications Outlet
RD	Ramp-down
RF	Radio Frequency
RIU	Radio Interface Unit

RMM	Remote Maintenance Monitoring
RMMC	Remote Maintenance Monitoring Control
RMS	Remote Monitoring Subsystem
RTCA	RTCA, Inc. (formerly Radio Technical Commission for Aeronautics)
RTN	Return to Normal
RTR	Remote Transmitter Receiver
RU	Ramp-up and Power Stabilization
Rx	Receiver
SINAD	Ratio of Signal plus Noise plus Distortion to Noise plus Distortion
SNAcP	SubNetwork Access Protocol
SOC	System Operations Centers
SRD	System Requirements Document
SRS	Software Requirements Document
SSS	Sub-System Specification
TCS	Tower Communications System
TDMA	Time Division Multiple Access
TOA	Time of Arrival
TOT	Time of Transmission
TRP	Timing Reference Point
Tx	Transmitter
UHF	Ultra High Frequency
V-burst	Voice Burst
V/D-burst	Voice or Data Burst
VA	Volt Ampere
V/D	Voice or Data
VDC	Volts Direct Current
VDL	VHF Digital Link
VHF	Very High Frequency
V	Volt
VRTM	Verification Requirements Traceability Matrix
VSCS	Voice Switching and Control System
VSWR	Voltage Standing Wave Ratio

APPENDIX B

RESERVED

APPENDIX C

VDL MODE 3 DUTY CYCLE CALCULATIONS

C.1 Introduction

The purpose of this appendix is to document the analysis of the maximum transmit duty cycles for the VDL Mode 3 system.

C.2 VDL Mode 3 Burst Type Symbols

At a symbol rate of 10,500 D8PSK symbols per second, a 30 ms VDL Mode 3 time slot could occupy 315 symbols. Ramp up occupies 5 symbols. The Synchronization Sequence is 16 symbols in duration. M_{UP}-bursts contain 32 symbols and M_{DOWN}-bursts contain 16 symbols of user data. For system configuration 3T, the M_{UP}-burst contains 128 symbols of user data, and the H-burst occupies 40 symbols of user data. A V/D-burst header occupies 8 symbols and a V/D-burst occupies 192 symbols of user data. The 2 symbols of ramp down are included in the calculations.

Table C-1 lists the number of symbols occupied by each of the following burst types.

Table C-1: Burst Type Symbols

Burst Type	Symbols
M_{UP}	5+16+32+2 = 55
M_{DOWN}	5+16+16+2 = 39
M_{UP3T}	5+16+128+2 = 151
H	5+16+40+2 = 63
V/D	5+16+8+192+2 = 223

C.3 System Configuration Symbol Computation

Table C-2 computes the number of symbols active if all available bursts are used for each system configuration.

Table C-2: Symbols per MAC Cycle According to System Configuration

System Configuration	Burst Makeup	Computation	Total Symbols per MAC Cycle
$4V_{UP}$	4 M_{UP} + 8 V/D	4*55 + 8*223	2004
$4V_{DOWN}$	1 M_{DOWN} + 2 V/D	1*39 + 2*223	485
$2V2D_{UP}$	2 M_{UP} + 8 V/D	2*55 + 8*223	1894
$2V2D_{DOWN}$	3 M_{DOWN} + 4 V/D	3*39 + 4*223	1009
$3V1D_{UP}$	3 M_{UP} + 8 V/D	3*55 + 8*223	1945
$3V1D_{DOWN}$	3 M_{DOWN} + 4 V/D	3*39 + 4*223	1009
$3T_{UP}$	M_{UP3T} + H + 6 V/D	151 + 63 + 6*223	1552
$3T_{DOWN}$	7 M_{DOWN} + 6 V/D	7*39 + 6*223	1611
$3V_{UP}$	3 M_{UP} + 6 V/D	3*55 + 6*223	1503
$3V_{DOWN}$	1 M_{DOWN} + 2 V/D	1*39 + 2*223	485
$2V1D_{UP}$	2 M_{UP} + 6 V/D	2*55 + 6*223	1448
$2V1D_{DOWN}$	3 M_{DOWN} + 4 V/D	3*39 + 4*223	1009
$3S_{UP}$	3 M_{UP} + 6 V/D	3*55 + 6*223	1503
$3S_{DOWN}$	1 M_{DOWN} + 2 V/D	1*39 + 2*223	485
$2S1X_{UP}$	3 M_{UP} + 6 V/D	3*55 + 6*223	1503
$2S1X_{DOWN}$	1 M_{DOWN} + 2 V/D	1*39 + 2*233	485

C.4 Maximum Duty Cycle Computation

With 315 symbols per 30 ms slot and 8 slots per Media Access Control (MAC) cycle, this means there are 2520 possible symbols to transmit in a MAC cycle. The 3-slot system configurations yield the same for the MAC cycle, as it is a constant 240 ms in duration. Based on the number of symbols occupied by each system configuration, the maximum duty cycle can be computed. Table C-3 includes these results.

Table C-3: Maximum Duty Cycles

System Configuration	Duty Cycle	
	Uplink	**Downlink**
4V	79.5%	19.2%
2V2D	75.2%	40%
3V1D	77.3%	40%
3T	61.6%	63.9%
3V	59.6%	19.2%
2V1D	57.5%	40%
3S	59.6%	19.2%
2S1X	59.6%	19.2%